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ARTHUR C. JONES, M.D.
Portland, Ore.


Diathermy

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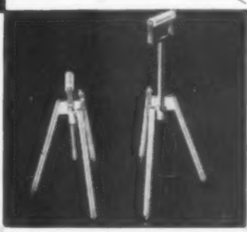

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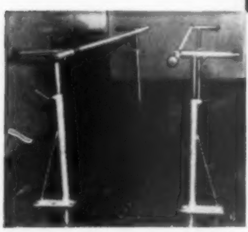

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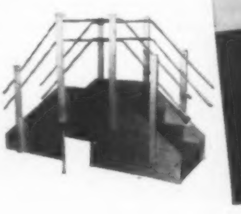

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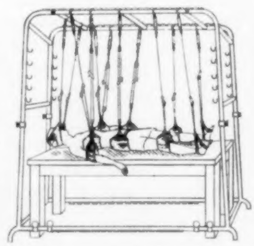

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Educational Goals in Physical Medicine and Rehabilitation

Gordon M. Martin, M.D.
Rochester, Minn.

Education, like the weather, provides amateur or professional with an ever-present topic for discourse, conversation or publication. Rarely is a person found who hesitates to express himself openly, often vigorously, and usually preemptorily on almost any aspect of either field. Absurd perhaps, yet two such major factors in the environment of man, with their obvious effects on his daily life, properly are objects of his attention.

All of us, at one time or another, very likely have railed at the weather, although we scarcely expect to change it. We cannot be persuaded, however, that we are not authorities on, and qualified critics of, teachers, courses of study, textbooks, buildings, physical facilities and even philosophies of education.

As critics in our own right as well as being subject to criticism by others, we must recognize that criticism, favorable or unfavorable, has its limitations. And we must remember that when individuals and minority groups are confronted with unfavorable criticism they react in various ways. Some shrug it off. Some are adrenergic, sudden, violent and call out the "fire brigades" to squelch the critic. A more sensible reaction is intelligently to evaluate criticism and, if it is valid, to modify activities accordingly.

With respect to our own still-developing field of physical medicine and rehabilitation, it is easy to assemble criticisms which reflect on our educational efforts. Perhaps some of the most basic and obvious of these are:

1. The number of competent physiatrists qualified and interested in medical education is insufficient.

2. The number of well-trained physicians practicing physical medicine and rehabilitation is insufficient.

3. The number of well-trained physical therapists and auxiliary personnel essential to an expanding practice in this field is insufficient. (The significance of the terms "therapist" and "auxiliary" will be evident later).

4. Sufficient uniformity or standardization in the training of specialists, therapists and auxiliary personnel is lacking.

5. Physicians other than physiatrists are not aware of the present scope of physical medicine and rehabilitation.

6. Some current educational experimentation is based on untenable philosophies relative to teaching of rehabilitation.

7. Textbooks and reference material too often are old — or are inadequate in scope and quality.

8. Refresher courses for specialists in the field also are inadequate.

In the light then, of the foregoing criticisms, what are some of the aims that should be kept uppermost in mind as we progress to educational programs of increased effectiveness? First, I think, we should realize that sound growth in education depends on evolution rather than on sudden upheaval. Some of us, in our zeal to bring help to an increased number of patients and to be of service to an increased number of physicians, tend to become discouraged when our ideas for teaching cannot be applied immediately.

To continue, let us consider briefly some important goals to be striven for in the following educational activities: (1) training of the medical student; (2) formal training of the physiatrist; (3) education of other specialists and other practitioners; (4) training of physical therapists; (5) training of auxiliary personnel; (6) refresher training for specialists, and (7) production of new books, articles and reference material.

Presidential Address, read at the 34th Annual Session of the American Congress of Physical Medicine and Rehabilitation, Atlantic City, N. J., September 11, 1956.

Section of Physical Medicine and Rehabilitation, Mayo Clinic and Mayo Foundation.

The Mayo Foundation, Rochester, Minn., is a part of the Graduate School of the University of Minnesota.

The Medical Student

Curricula of progressive medical schools cannot be static. Some topics that, 20 years ago, required of the student hours of reading and study now merit only a few paragraphs. Trends in research and accumulation of new knowledge are changing the areas of emphasis in teaching and clinical practice. In medical schools, consideration is being given to replacement of the block system of teaching by an integrated system,[1] which allows the student earlier acquaintance with clinical material. Preventive medicine and public health, genetics, geriatrics, psychiatry, and care of the chronically ill and handicapped are a few of the areas wherein expansion and curricular adjustments are needed. The schools are caught in the dilemma of the desirability of adding new courses and the undesirability of augmenting the already overcrowded curriculum.

In physical medicine and rehabilitation we must work for practical educational programs that can be incorporated readily in current teaching schedules and can be changed as requirements change. Physiatrists on the staffs of medical schools should plan short, carefully organized courses, which will serve primarily to orient the student as to the place of physical medicine and rehabilitation in the patient's care.

In rounds, clinics and clerkships the student should be enabled to see for himself the effectiveness of physical measures in relation to clinical problems. He should learn fundamentals of prescribing and supervising physical treatment in frequently met clinical conditions, such as arthritis, hemiplegia, backache and the painful shoulder.

One group maintains that rehabilitation is everybody's business, that the patient can best be rehabilitated by the general practitioner or specialist who first has the patient in charge. This notion, should it prevail, would result in haphazard, inadequate and ineffective handling of many patients. Physicians without adequate training or experience in the many facets of rehabilitation would be encouraged to delegate major responsibility to therapists and well-meaning auxiliary personnel whose base, though sound, is insufficiently wide to qualify them for complete therapeutic responsibility. The medical student who has had the opportunity to observe that special knowledge and complex plans are necessary to rehabilitation of the disabled, will, when in practice, seek qualified consultants.

The Specialist in Physical Medicine and Rehabilitation

The first goal on the road to training of specialists must be recruitment of people to train. During the middle years in medical school, the student's thoughts begin to turn to specialization. The need for physicians trained in physical medicine and rehabilitation, and the almost limitless opportunities for varied work in the field, should become evident to the student early in his clinical training. Recruitment will fail if physical medicine and rehabilitation is taught only as a short, didactic course in the last semester of the senior year.

It is to be hoped that the recent graduate, whose interest in physical medicine and rehabilitation was awakened in medical school, will have his interest fostered in the course of his internship. If he has this good fortune, he will seek residency in the specialty. Although the number of approved residencies has gradually increased, at present only about half of them are filled. To date, moreover, the residency program and the approaches used in training are as variable as the number of training centers. Further, it is apparent to the certifying board in physical medicine and rehabilitation, that in some approved residencies, phases of training which it deems essential are neglected.

Mere exposure to good clinical practice in physical medicine and rehabilitation is not sufficient. The residency program must provide time for the resident to learn neurologic diagnosis and evaluation of neurologic problems through work with a neurologist. The excellent liaison that has developed between departments of physical medicine and rehabilitation on the one hand, and neurologic and neurosurgical services on

the other hand, has resulted in an encouraging increase in the number of referrals of neurologic cases to departments of physical medicine. Electromyography is becoming essential, too, in diagnosis, in evaluation of the progress of a patient and in clinical research; the resident should become proficient in its use. Some clinical training, likewise, should be provided in other specialties that are increasingly served by specialists in physical medicine and rehabilitation; these include rheumatology, orthopedic surgery, general medicine and psychiatry.

Residency committees, the specialty boards and organizations such as this Congress are advocating that the time allotted to research in a residency program be increased. Whether in our specialty or another, the difficulty in providing combined clinical and research training outside a university medical center is obvious. Even after our period of training, many of us have experienced difficulty in finding the time to become seasoned clinician-investigators. Of them, Pruitt[2] has written: "They have placed themselves in the perilous position of striving to serve two masters. They face the probability that their efforts will be deemed amateurish by the professional investigators and they live with the frustration that comes from the encroachments of a growing practice on the time that they might, given choice, devote to research. Yet it is the production of this kind of specialist, the clinician with the devotion both to his patients and to the pursuit of the scientific method, that will be fostered by a residency program in which the enrolled students are encouraged to consign an appreciable time to an investigative effort." The clinician-investigator serves as a liaison officer between the clinician and the laboratory. "He will bring to the laboratory a perception of crucial clinical issues. He may give to investigators more conversant with the fundamental knowledge a sense of orientation and direction."

Other goals in the training of the resident in physical medicine and rehabilitation have been presented in more detail in at least two previous presidential addresses before this organization.

Education of Physicians Other Than Physiatrists

In the past decade, orientation courses in physical medicine and rehabilitation have been added to the curricula of more than 75 per cent of American medical schools. The majority of physicians and specialists who are practicing today, however, were not exposed to the subject in medical school. To educate them concerning the specialty is a tremendous task for us who represent only 1 per cent of members of the medical profession. Regarding rehabilitation, Shands[3] has estimated that 80 per cent of physicians are still apathetic relative to rehabilitation and that only 15 per cent have an interested attitude.

Shands[3] has tossed out a criticism that must be considered seriously. "This group (physiatrists) has been doing a magnificent job in some communities in showing the public and profession what can be done. However, the efforts of this group have been more successful in convincing citizens' committees, hospital administrators, and lay medical groups of the worth of good rehabilitation programs, than they have in convincing their fellow physicians."

To change this state of affairs, our first effort should be expended on Shands' 15 per cent who have an interested attitude. If they are shown effective physical medicine and rehabilitation in action, if only on a limited scale, they may become active supporters and participants in the work.

General means of informing our fellow physicians about our specialty are the following:

1. Practical papers and exhibits should be presented at meetings of the American Medical Association and of state medical societies.

2. An increased number of practical articles on physical medicine and rehabilitation should be offered for publication in the *Journal of the American Medical Association,* state medical journals, *GP* and other publications of wide circulation.

3. Publication of sensational articles in newspapers and lay magazines should be

discouraged, since these tend to antagonize, alienate and sometimes even nauseate physicians, both physiatrists and others.

4. Extra effort should be made to obtain close co-operation of the referring physicians in the successful treatment of a few patients; this can be of more educational value than many articles and speeches.

5. Physicians other than physiatrists should be invited to attend, and to take part in, meetings of this Congress and other meetings pertaining to physical medicine and rehabilitation, at state and local levels.

6. An increased number of physiatrists should become established in cities of moderate size, where they will fulfill the function of training centers for their associates in general practice and such specialties as may be represented.

The lack of thought being paid to physical medicine and rehabilitation by physicians in cities of moderate size recently was brought to my attention. A senior fellow was considering returning to a city of 60,000, where he formerly was in general practice. He wrote to two physicians regarding his interest in practicing physical medicine and rehabilitation in that community. The initial reaction of both was extremely pessimistic and probably typical. Each of the two local 400-bed hospitals, he was told, had a therapist (not qualified) and the physicians were well capable of referring their own patients. It was evident that the economic prospect of another physician's working in the city on a referral basis was causing apprehension. However, three months later the same senior fellow visited the same two physicians, as well as most of the other physicians in the county and the administrators of the two hospitals. Some thinking apparently had been done in the interval. The entire attitude had changed. The young physiatrist is now being urged almost unanimously to return. He is being offered freedom and co-operation in establishing his practice. In a few years in that city, an overworked physiatrist may well be seeking an associate because the local physicians will have been educated as to the place of physical medicine and rehabilitation in modern medical practice.

Education of the Physical Therapist

That the training of many physical therapists leaves much to be desired is known to us. Recently one of my associates was astonished at the manner in which a qualified therapist, graduated from an approved school at a university medical center, was treating a patient who was recovering from a lumbar laminectomy. Radiant heat was applied for 15 minutes to the patient's thigh through towel, trousers and underwear. Following this, some haphazard manual resistive exercises were given to the same fully clothed patient. The therapist, who appeared conscientious, claimed to be working under the orders of a physician who had left the therapist free to try whirlpool, heat lamp or diathermy, and to give exercises in any way that he saw fit.

Certainly there is need for increased standardization even of basic technics as they are taught to students of physical therapy. First efforts are now being made to this end through regular conferences of medical directors and educational administrators of recognized schools. Textbooks and manuals on technics are not yet adequate in quantity or quality. Production of good teaching materials, which would be available and acceptable to all schools, must be encouraged.

Uniform principles regarding the responsibilities, the scope and the limitations of the work of the physical therapist need to be taught in all of the schools. In some schools, usually where medical direction is nominal, emphasis is placed on training the therapist to act as a prescriber of treatment as well as a therapist. Encouragement of physical therapists to engage in private practice, exerted by certain organizations and some physicians, is actually an attempt to legalize the practice of medicine by persons who have had only 1 or 2 years of technical training and no actual medical training. This can result only in cultism and, after enough serious errors have been made, in discredit of physical

therapy in particular and of physical medicine in general. Courses in ethics of both the practice of medicine and the practice of physical therapy are required. They should be taught by a physician, and also by an experienced therapist who has insight into the essentiality and advantages of practice under direct medical supervision.

Relative to the physical therapist, another educational aim should be to bring about more nearly unanimous support than now exists of the American Registry of Physical Therapists. The Registry Board, which was established by the physicians of this organization, attempts to maintain standards of education and prerequisite training, ethical standards and evaluation of technical competence. Its membership consists of medical directors of several schools of physical therapy and two representative physical therapists. The educational department of a leading state university helps in its examining procedures. Yet the Registry is flouted by some physicians and therapists who endorse haphazard methods of evaluating competence and are willing to permit substandard ethical principles of practice to flourish. Some state laws of licensure for physical therapists have been established with apparent disregard of standards set by the Registry Board. As physicians and members of the Congress, we should assist the Registry to be the controlling group relative to training in, and practice of, physical therapy. To remove education, clinical training and clinical practice from the direction of physicians, and to require the therapists themselves to assume direction in these areas, would be to step backwards toward the cultism of the "physiotherapists" and "masseurs" of a generation ago.

Recruitment of candidates for training in physical therapy should continue to be the responsibility of everyone interested in the field. Many schools are not filled and, with the continued high incidence of postgraduate matrimony, the number of working therapists is not increasing at a rate adequate to meet requirements. The problem is not one of establishing additional schools but one of improving existing schools and recruiting enough candidates to fill them to capacity.

Education of Auxiliary Personnel

The most confused picture of education of personnel employed in the work of rehabilitation concerns workers other than physical therapists, occupational therapists and social service workers. Even the terms by which these people are known and the scope of their activities in most instances are far from clear. At present, everyone who in any way assists the handicapped person wants to be on the band-wagon and to be called a therapist. This is true of the "bibliotherapist" who helps the patient select a library book, the "music therapist" who, among the other things, may play a record for him or the "rehabilitation therapist," a title which apparently can include all the sisters and the cousins and the aunts. Here, I try to limit terms to the following: (1) "physiatrist," "physician specializing in physical medicine and rehabilitation," or "specialist in physical medicine and rehabilitation"; (2) "physical therapist"; (3) "occupational therapist" and (4) "auxiliary," used as a noun or an adjective.

"Manual arts therapist" and "corrective therapist" are terms used in the Veterans Administration. However, even for these, educational standards and requirements are loose and as yet educational programs for them are not recognized by the Council on Medical Education and Hospitals of the American Medical Association, which group, I believe should be requested to set standards for education of all personnel concerned with treatment of the ill and disabled.

Education of persons who are needed in the work of rehabilitation should be developed under the supervision of physicians. Pilot courses should be established in university medical centers in conjunction with active programs of physical medicine and rehabilitation. This would permit the student to obtain understanding of clinical and nonclinical aspects of the work; nonclinical courses would be given mainly in various undergraduate

departments of the university. Prerequisite courses in biological sciences, sociology and psychology could lead up to courses directly related to the handicapped. Use could be made of persons possessed of special skills in such fields as speech, psychology, vocational testing and various crafts.

To date these auxiliaries often have entered upon their work by chance, have been trained by trial and error or have been self-trained and they now are attempting to establish educational programs. Several groups are going off on separate tangents and are tending to develop their educational programs without relation to medicine. If auxiliaries are properly trained, we physicians will make use of them and, therefore, we should stand ready to guide their educational efforts.

Refresher Courses for Physiatrists

Another educational need is refresher courses for physiatrists and other physicians who devote part of their time to physical medicine and rehabilitation. With new developments in research, functional anatomy, physiology, biophysics, electromyography and clinical physical medicine, it has become increasingly difficult for the physician trained in the earlier days of the specialty to keep up to date by reading only. Many feel the need of being brought up to date by sitting under outstanding teachers of the basic sciences as well as under members of our own group who have special knowledge and interest in certain aspects of the specialty.

I have been much impressed by the refresher courses in anesthesiology, another relatively new specialty. This fall, at the annual meeting of the American Society of Anesthesiologists, two days are being devoted to a refresher course, consisting of 144 hours of formal classes taught by members of the society and others. The survey will cover all aspects of anesthesiology and related basic sciences. The success of this annual refresher course has led to the establishment of an additional mid-winter refresher program.

It is hoped that either the American Congress of Physical Medicine and Rehabilitation or the American Academy of Physical Medicine and Rehabilitation will seriously consider embarking on such a program in the near future.

New Publications

It remains to point out the need for new, up-to-date, and more applicable publications for educational use in all the various areas here considered. The field is becoming too complex for the treatise or textbook written by a single author. In general, however, special monographs do not seem to meet the need. It appears that only carefully edited volumes composed of uniformly planned chapters, written by outstanding authorities, will meet the requirement for textbooks. At least one of the members of this Congress is making first efforts in this direction. It is hoped that his venture will prove successful and that it may inspire others to try other approaches, so that the fundamentals may be presented in satisfactory textbooks for the use of specialists such as we are, medical students, residents, physicians who are not physiatrists and therapists in training.

Dr. Bentley Glass,[4] of Johns Hopkins University, has pointed out the need in all fields of science, for improved books in which increased emphasis will be placed on the philosophy and history of science. He wrote, "Nine out of ten books present their science as a series of established facts and polished generalizations handed down in an authoritarian fashion. How rarely does one find any evaluation of evidence or any description of the experimental means whereby the evidence was gathered. How trebly rare to get any hint of the errors and confusion and false starts of able scientists or any indication that the 'truth' of today is so often a synthesis of views once held to be mutually contradictory. To teach facts and theories in an authoritarian way vitiates the spirit of science. We are part of a living, developing community of science and only by paying heed to our past and considering our foundation can we fulfill our social responsibility."

Our Responsibility

For each of us there is an educational task, or even several of them. Even though we cannot all teach in medical school, or write textbooks, we should find our niches and we should work enthusiastically, realistically and honestly to aid in the evolution of education in physical medicine and rehabilitation. Achievement of many of the goals in education cannot be immediate. But we must maintain our ideals for, as Abraham Flexner[5] wrote, "Without ideals, without effort, without scholarship, without philosophical continuity there is no such thing as education."

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Instrumentation and Equipment for Quantitative Clinical Muscle Testing

Willis C. Beasley, Ph.D.
Washington, D. C.

Over the past 10 years, I have pursued continuously a concentrated investigation and experimental research program on methods for quantitative muscle testing, with particular emphasis on applications to clinical evaluations of muscle functions. In general, this long-term research has been guided by a four-fold purpose: (1) to evaluate objectively, through direct experimental procedure, the kind and amount of error involved in clinical muscle testing as currently practiced; (2) to develop adequate methods for objective and accurate measurements on the quantitative aspects of muscular dynamic contractile processes as they relate, for example, to neurological diseases, metabolic diseases, paresis regardless of etiology, and other clinically important forms of motor dysfunction; (3) to acquire, through a long-range and systematic program of testing, comprehensive knowledge on the character (pattern) and force level of contractile processes of the major skeletal muscle groups in their respective natural functions among both normal and pathologic subjects drawn from population samples permitting estimation of trends for age, sex, occupational and significant anthropometric factors; (4) finally, to make available the knowledge acquired in such form that it may become effective in clinical practice, and so that the technics developed can be adopted readily for research and routine evaluations in physical medicine and physical therapy, chemotherapy, orthopedic surgery, treatment of neurological diseases and in other similar applications of direct interest to physiatrists and related specialists.

Although more than one million muscle tests have been performed and over 3,000 subjects, including patients and normal individuals, have been studied in detail, the initial objectives are far from completed. Sufficient knowledge has been acquired, however, to provide definite conclusions relative to the basic question as to what is needed in clinical procedures that does not exist there at the present time. Furthermore, it is now known what directions to follow in completing the information that will be of greater help in solving many of the problems.

This paper describes the essential physical and functional characteristics of the most satisfactory instrumentation and equipment developed during the investigation. Description of construction details is limited to a minimum, but emphasis is placed upon the more useful applications to evaluation of clinical procedures, and especially the functions served in the research. Numerous papers will be published on different aspects of this investigation. The information given in this report provides an introduction on the instrumentation and methodology that is basic to interpretation of results to be described in the other publications.

Design Requirements for Instrumentation

From a preliminary analysis of the quantitative factors that could be investigated in clinical muscle testing procedures, the design requirements for versatile instrumentation were developed from the following considerations:

1. Measuring forces from a few tenths of a pound to many hundreds of pounds requires many linear scale ranges to insure equal accuracy within each range.

2. The phenomena to be studied vary from a few milliseconds to many seconds per event; hence, a system with correspondingly fast response time is required.

Director, Biophysics Research Laboratory, Bethesda, Md.; Research Biophysicist in Physical Medicine, Research Foundation of Children's Hospital, Washington, D. C.

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This research program was supported by departmental funds, Division of Public Health Methods, U. S. Public Health Service, during the period (1944-52 inclusive) in which the author held the appointment of Biophysicist.

3. The events necessarily present different patterns of behavior in time, therefore graphic recording is indispensable.

4. Because a great variety of experimental arrangements with reference to the subject is involved in measuring the responses of the many different muscle groups and joint motions, a force-sensing device (load cell) that is light in weight, stable in performance and basic calibration, and capable of a wide range of linear stress-strain reaction is needed.

5. A readily adaptable system capable of extreme versatility for attaching the load cell to the body segments of the patient is essential.

6. Physical equipment permitting comfortable but secure positioning of the patient in a wide variety of approaches, with surrounding arrangements available for attaching tension lines to stable anchorages in all conceivable directions, is necessary.

Instrumentation and Method

Instrumentation was not the goal of this research, but it was an indispensable phase of the initial and continuing experimental procedures. There is much misunderstanding on this point. The view held by many that instrumentation constitutes method is encountered more often than not; but actually the two ideas are not logically commensurate. In fact, a major objective in this program was to acquire knowledge by different methods, using the same instrumentation, in order to select those that gave the most useful and valid results as judged by criteria based upon kinesiological considerations, as well as upon demonstrable applicability to clinical evaluations.

The type of instrumentation an investigator employs imposes limitations or permits wide latitude in the methods that can be explored and implemented. As a formal definition, therefore, instrumentation may be regarded as a necessary but insufficient constituent of method. Because of the unique character of the problems investigated in this research, the instrumentation and equipment likewise is uniquely adapted to the experimental requirements. The whole investigation benefitted to the extent that instrumentation did not impose limitations on methods to be explored. Hence, thorough attention was given to the design requirements for instrumentation that would be adequate to the field of problems represented in methods for clinical muscle testing.

A period of 5 years was devoted to constructing and reconstructing instruments and accessory equipment to achieve these specific requirements and others derived from exploratory experimentation on some 40 muscular actions, each being studied in a variety of ways, on both normal subjects and paretic postpoliomyelitis patients. A brief description is given of the various instrumental and accessory equipment components in their final form, together with an indication of their specific utility in the methods that were finally achieved and in attaining the kind of information sought in the total investigation.

Electronic Instrumentation

Original electronic and force-sensing devices (load cells) were developed and constructed as an essential aspect of this research. Consideration was given to many alternatives for instrumentation, but the only system that potentially would fulfill all of the general requirements as set forth was an electronic system utilizing wire strain gages in the load cells. When this program was initiated in 1944, a few so-called strain-gage amplifiers were available, but none could be used directly in the unique requirements of the experimental procedures that were visualized for this investigation. Consequently, a complete instrumental design was accomplished with all of the controls adapted specifically to the muscle testing objectives. The total unit, which is called an electronic myodynagraph (EMD), comprises an electronic unit, load cells, and recording system. Two types of load cells were developed; one is called a manual force gage (MFG), the other an axial tensiometer gage (ATG). These will be described separately. The recorder used depends entirely upon the kind of events to be recorded, the major consideration being response rise-time requirements, as discussed in a subsequent section.

The electronic unit (fig. 1) comprises the usual components of a carrier system, which includes an oscillator, transducer bridge, stable R-C amplifier, and output recorder control circuit. The amplifier works at a constant gain level for all of the different scale ranges, the latter being controlled by a precision voltage divider network, providing six calibrated force scales (in pounds) as follows: 0-10, 0-20, 0-50, 0-100, 0-200, 0-500, when used with either the MFG or ATG-1. When used with ATG-10, which is one-tenth as sensitive as ATG-1, the same scale markings indicate 0-100, 0-200, 0-500, 0-1000, 0-2000, and 0-5000 lb. respectively. A built-in electronic calibrator facilitates maintaining secondary standard accuracy during use. Calibration against primary weight standards is carried out occasionally to maintain accuracy of the electronic secondary standard.

By substituting a plate with kilogram markings, instead of pounds, using kilogram weight standards in the primary calibration, and increasing by 10 per cent the amplifier gain setting, the force scale ranges become (in kilograms) exactly 0.5 the indicated ranges given previously in pounds. These ratios depend upon the built-in ratios of the resistors used in the input voltage divider, and could be arranged to suit any experimental requirement. Obviously, the system adopted is easy to read in either the English or metric system, and since the recorder tape used most often has readable divisions in 1 per cent units, the recordings are readily translated mentally.

The output recorder control circuit serves an entirely practical function of protecting the zero balance meter from overload and saving paper or film, depending upon the type of recorder used. This is accomplished by two relay systems, designated as the protection and recording relays respectively. The protection relay opens the circuit to the meter and recorder whenever the voltage across this section of the circuit exceeds by 15 per cent the amount required for maximum or 100 per cent scale reading of the output indicator. This occurs, for example, when a subject's muscular effort exceeds the scale range in operation at that moment. The circuit will not function until the scale setting has been switched to a less sensitive range. The recording relay starts the recorder when the output voltage has exceeded a certain minimum, pre-set level, usually maintained at 10 per cent of full scale on any particular scale. This control enables the investigator to ignore the recorder and give attention to the subject or other

Fig. 1 — The most recent model of Beasley's electronic myodynagraph, developed in 1955.

matters during a trial run, and also limits the amount of tape to the minimum amount required for a given trial. The recorder also stops as a result of this control when the effort level falls again to this critical value.

Recorder Considerations

The amplifier of the EMD alone has a response rise time of 1 millisecond. Systematic experimental results have shown this minimum time to be sufficiently fast for all measurements of human muscular tensive forces, either voluntary or reflex. It was not designed for nor intended to be used as a means for amplifying either nerve or muscle action potentials, which require much faster response time. The output level of the amplifier is sufficient to operate any of the commercial ink-writing recorders requiring 1 milliampere or less for full scale deflection. This includes, for example, the Esterline-Angus and the General Electric photo-electric types. The GE recorder has available a wide range of elements, differing in response characteristics, from which the investigator can choose. After considerable experience, I prefer the GE movement designated as form 27, pivoted type, as serving the widest range of requirements for the indicated minimum response time.

The response time of these recorders is sufficiently fast for all voluntary isometric tensive responses, and for passive stretch tests when the rise time to full scale deflection is not less than 0.1 second. For recording voluntary isometric tension, passive stretch reflex transients at a rise time of 0.1 second or more, and any other responses no faster than this, these recorders are the best choice for routine testing. When using recorders of this type, the investigator must make sure that the events to be recorded definitely do not have a rise time briefer than 0.1 second. If they do, the readings obtained in the recording will be less in value than the levels actually attained by the muscular contraction.

Reflex tensions faster than this, and studies on maximum speed of muscular contraction time (even voluntary), can be recorded accurately with such direct-writing recorders (either ink-writing or heated-stylus types) as Sanborn, Edin, Brush and Photron. In choosing recorders from either class, the investigator must give attention to both over-shoot and nonlinearity characteristic of the recorder, or he will be faced with many troublesome and time-consuming adjustments of data. Each of the recorders in the second group requires more power to operate than is available at the output of the EMD; therefore, when any one of these is chosen, it must be provided with its own intermediate amplifier, which may be operated directly from the output of the EMD. Under this arrangement, the calibration and other built-in controls of the EMD are still available for the investigator's convenience.

One of these faster direct-writing recorders is necessary for accurately registering the true maximum of responses that have no less than 5 milliseconds rise time, which is the practical limit for any of the four recorders mentioned. This choice is likewise the best for clinical routine, when exceptionally fast (but not the fastest possible) responses are to be recorded, since the results are available at once for inspection and study, and the recorders are easily managed. When it is necessary to measure tensive forces faster than 5 milliseconds (and there are some examples of these), it is necessary to use a properly selected cathode ray oscilloscope (CRO) with a recording camera, or a mirror galvanometer type of recorder. Here one has considerable latitude in choice of units.

When the responses of interest can be recorded one at a time at intervals of 2 or 3 minutes (allowing time for resetting the camera and other equipment), a suitable CRO and Polaroid Land camera (PLC) type adapted to CRO photography offer a method of recording with immediate viewing of results. When recording a stretch reflex transient imposed upon a concurrent and sustained isometric tension effort, a technic which I originated and have used extensively, the CRO should have a slow sweep function as prolonged as one trace per 10 seconds. This permits recording the continuing but not necessarily constant level of isometric tension (Y-axis) with

a rapid stretch reflex tensive component superimposed, with no relevant limitation on the rise time of the recorded transient. The entire trial of 10 seconds' duration may be recorded as a single CRO screen traverse by a PLC photograph. This method is valuable for exploratory experiments preparatory to long runs in order to standardize procedure with film economy and assurance of success, as well as for sampling tests when it is necessary to view results immediately, as often happens in the clinical situation while the patient is available for study.

For sequential, uninterrupted recordings a CRO and continuous film camera, such as Dumont or Grass provides recordings with no relevant limitation on rise time of responses (Y-axis), and in this instance with no pertinent limitation on the temporal spacing of events (X-axis). The disadvantage, of course, is that the investigator must wait until the films are processed before viewing the recordings. This is true also of the mirror galvanometer type of recorder. The latter system has fewer applications than the CRO system; hence, for economy in the purchase of equipment, the CRO is preferred for all recordings in which rise time of response is less than 5 milliseconds.

Finally, a technic with which I am working at present should be mentioned, since much interest has been shown in it by others concerned with related problems. In some neuromuscular functions it is essential to correlate electromyographic responses (bioelectric potentials) and electromyodynagraphic responses (muscular tensive forces) on the same time axis in order to identify presence or absence of parallel changes in the two realms of events. This may be accomplished effectively by using a CRO system, continuous motion film camera, and an auxiliary electronic switch with a switching rate of at least 100 kilocycles per second. This assures that events with a rise time as brief as 5 microseconds will not be distorted. No events encountered so far are as brief in time as this, but it is always a good precaution to allow a wide margin of freedom in the rise time of the amplifying and recording system, relative to the events to be recorded and measured.

With this method, two independent channel recordings appear on the CRO screen. One is derived from the EMD output and shows the level of muscular tensive force. The other is derived from either surface or needle electrode samples of bioelectric potentials from the same muscle. Proportionate changes, or simply temporally associated changes without proportionality, in the two recordings establishes parallelism in the events, even though there is not quantal correspondence. There is no assumption here that the changes in quantity of bioelectric potentials in the sample will account for all of the change in muscle tension, nor conversely.

An important point in this connection is that recording bioelectric potentials by either needle or surface electrodes always involves detecting only a relatively small sample of the total of bioelectric events in the whole muscle during contraction, even when integration of a multiplicity of potentials through surface electrode pickup is employed. On the other hand, measuring the tensive force of contraction registers the total biomechanical, contractile process of the whole muscle at a given moment. Measurements of muscular tensive force constitute a more meaningful index to muscle functions for rehabilitative and therapeutic objectives than do recordings of bioelectric potentials. The latter, however, are generally acknowledged to contribute more definitive data for diagnosis, particularly with reference to lower motor neuron lesions. In rehabilitation and therapy, we are finally interested in what the patient can do with muscles. The final motor function, therefore, is the center of interest in measuring effectiveness of therapeutic procedures.

Tensive forces in a muscle can be recorded under conditions of "sampled" bioelectric silence. Also, under rare circumstances, impressively large changes in bioelectric potentials may be detected without any recordable changes in muscular tensive force. It is clear, therefore, that parallel recordings for the two

systems of events offer many possibilities in research, for confirming differential diagnosis and charting of progressive changes in neurological diseases, and in detecting with greater confidence effects from chemotherapy and any other form of treatment in which especially minimal changes have prognostic significance. Much research along this line is indicated before indices that serve to define what patterns of events constitute prognostic symptoms are adequately confirmed. The technic as described with the parallel electromyodynagraphic and electromyographic recordings provides the simplest and most adequately controlled method as yet devised for studying these two realms of events concomitantly, especially since the facilities are readily adapted to experimental investigation of practically all of the more important skeletal muscle groups, and in situ.

Purpose of the Manual Force Gage (MFG) Methods

This force-sensing unit (load cell) was developed specifically to answer two general classes of questions: (1) What are the forces, quantitatively, that are actually applied against the subjects' body segments when an examiner assigns a rating of strength in accordance with the customary manual grading definitions? (2) What particular muscular actions among both normal subjects and paretic patients can be managed satisfactorily by manually applied force, and are any of these managed better by such means than by other methods as with a tensiometer, where the reactions of the patient are not subject to influence by particular mannerisms of the examiner?

Answers to the first class of questions, taken in comparison with measurements on the same subjects with the tensiometer methods described later, and both of these sources of quantitative data interpreted in relation to manual grades assigned independently by experienced clinical physical therapists, provide the essential observations for evaluating objectively the error magnitude in clinical muscle testing as employed generally in the United States. Thus an immediate result from suitable analysis of this information is to compare directly the objective force responses of patients classified as normal by clinical methods with those on samples of subjects drawn from nonclinical normal populations. Differences between the distributions of objective measurements on the two sample populations indicate whether there is significant error, either theoretically in the probability sense, or practically in the amount, between clinical and objective criteria of normality.

By correspondingly relevant procedure, a quantitative scaling of all manual grade classes based upon objective measurements can be derived and compared with the arbitrary percentage ratings commonly used. Thus, clinical manual grades were obtained in this research for all of the muscular actions that were tested by EMD methods independently. By classifying the objective measurements of forces in accordance with the manual grades that were assigned, and comparing these distributions with nonclinical normal values, it becomes possible to derive actual quantitative estimates of the true percentage level for each of the various clinical manual grade classes relative to nonclinical normal values. In addition, by comparing the MFG quantitative tests with those obtained from the tensiometer tests on the same population groups, it becomes possible to estimate the error of MFG tests as gaged by a nonmanual method. Obtaining systematic information of this type was considered to constitute the most valuable and direct experimental design for evaluating the error of clinical muscle testing. By "error" here is meant the amount of difference between a presumed entity and the actual existent as measured. I do not mean that the examiner made a mistake which could have been avoided, excepting the extent to which the method itself imposed a limitation upon what the examiner could do.

In order to have instrumentation that would represent the reaction between examiner and patient in a manner equivalent to the forces existing when the usual clinical judgments are made, it was necessary to test different MFG designs to ascertain what kind permitted

the examiner to apply the same force with the device worn on the hand that he is capable of applying with the bare hand. Many discrepancies exist between these two approaches. Using a device in the hand at first imposed limitations upon the examiner in applying an axial load to the body segment, compared with the forces the same examiner, using the same approach, could apply with the bare hand.

The final design of the MFG, and the standardized methods for using it, resulted from a series of systematic and tedious experimental trials extending over several years. During this phase of the investigation, there were numerous designs of the MFG. Sequential modifications of the designs resulted from knowledge gained through direct experience in testing an extensive set of muscular actions on both normal and paretic patients, as well as comparative tests on the abilities of physical therapists to apply forces against rigid bars, which were arranged to simulate the conditions encountered in usual clinical muscle testing procedures. The latter experiments served another useful purpose in establishing the maximum levels of forces physical therapists can apply in relation to the direction of approach and general body position of the examiner, independently of responses by human subjects that introduce an additional source of variance unrelated to the primary information most germane to the immediate problem. Obviously, the examiner's ability to apply force determines the absolute limit for evaluating manually whether an action is normal. Everything in excess of this limit will be called normal, necessarily, no matter how far above the examiner's limit a given action is in fact.

Development of a manual force gage that eventually satisfied the requirements of valid methodology as determined from empirical results, and with manifest adaptability to the diverse situations exemplified in manual muscle testing procedure, involved extensive and sequential experimentation over a period of 5 years. A description is given here only of the final design, with indications of the specific advantages of associated methods in solving the problems as posed initially for the investigation and in providing continuing utility as a means for obtaining certain classes of information in clinical muscle testing routine.

The following description gives the essential construction detail of the final unit, which is designated MFG-type C (fig. 2). The duralumin shell has the form of a cylindrical section and measures 2½" by ⅝". A cylindrical load shaft ½" in diameter projects above the face 5/16". On the base side of the shell a hard rubber cap ⅜" by 1⅝" is fastened. This rubber cap gives a firm but comfortable surface pressure against the examiner's hand in use. A stainless steel sleeve, 7/32" by 1¾", projects from the side wall and serves as a protecting conduit for the 4-conductor cable, 20' long, which connects the part of the bridge circuit inside the MFG to appropriate points in the transducer bridge circuit of the EMD unit. The assembled MFG unit weighs 6 oz.

Inside the MFG shell is a duralumin disc, 0.08" by 1.75" diameter, mounting four Baldwin wire strain gages, bakelite type SR-4, ABD-11, 120-ohm. Under load all four gages are active — two in compression and two in tension. The arrangement has several advantages. It provides automatic temperature compen-

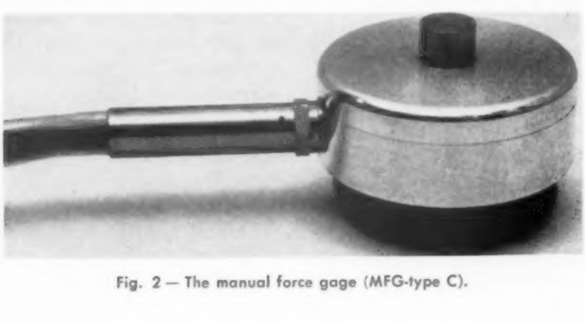

Fig. 2 — The manual force gage (MFG-type C).

sation between these four bridge components, thereby reducing temperature drift. It compensates for nonlinearity of the mounting disc deformation with load and provides maximum stress-strain sensitivity for the particular design as employed. In the lower chamber of the main shell, a rigid fiber terminal strap mounts three terminal lugs where connection is made between the fragile strain gage leads and the relatively massive extension cable. The extension cable is subjected to radial binding pressure at the entrance hole in the wall of the shell by means of a neoprene O-ring, which is compressed when the cable sleeve is tightened. This arrangement, aided by the rigid terminal strap, prevents tension on the strain gages when the extension cable is subjected to movement and other stresses during use.

The MFG is calibrated for axial load relative to the control axis of the cylindrical shaft. Precision weight stacks, either pounds or kilograms, are used for standardizing the scales as read on the recorder tape, the meter of the EMD unit, or any other output indicator. Measurements are, therefore, in gravitational units of force or simply weight. An axial load on the cylindrical shaft acts through a mechanical coupling to deform slightly the duralumin disc on which the strain gages are cemented. The axial load is applied over an area of approximately 0.016 sq. in. at the center of the disc, producing a "dishing" deformation. The design permits axial loads up to 200 lb. without exceeding the elastic limit of duralumin, allowing a 40 per cent margin of safety. The precision calibrator, which is used for establishing

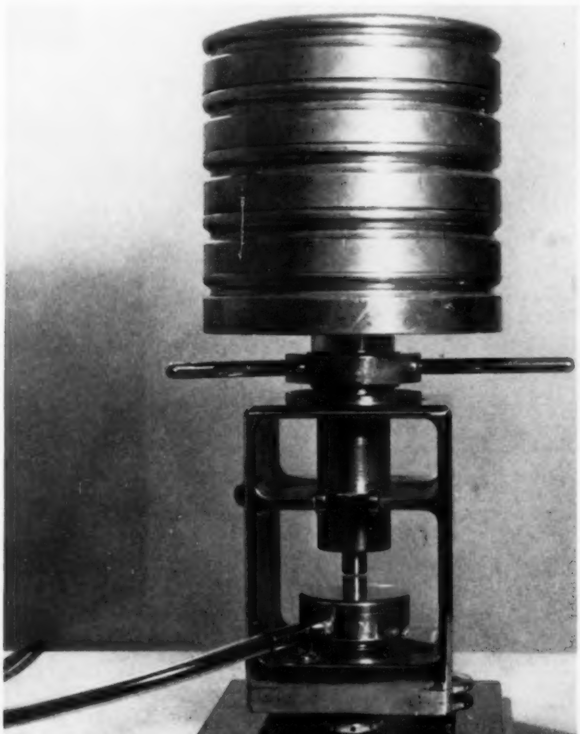

Fig. 3 — Precision calibrator used with the manual force gage (MFG).

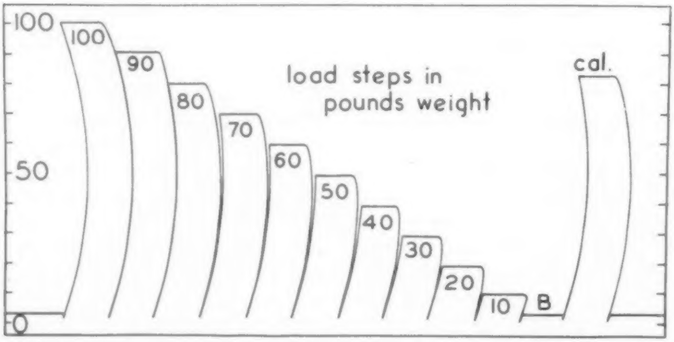

Fig. 4 — Calibration recording showing relation between axial load (lb.) and indicator deflection on record tape.

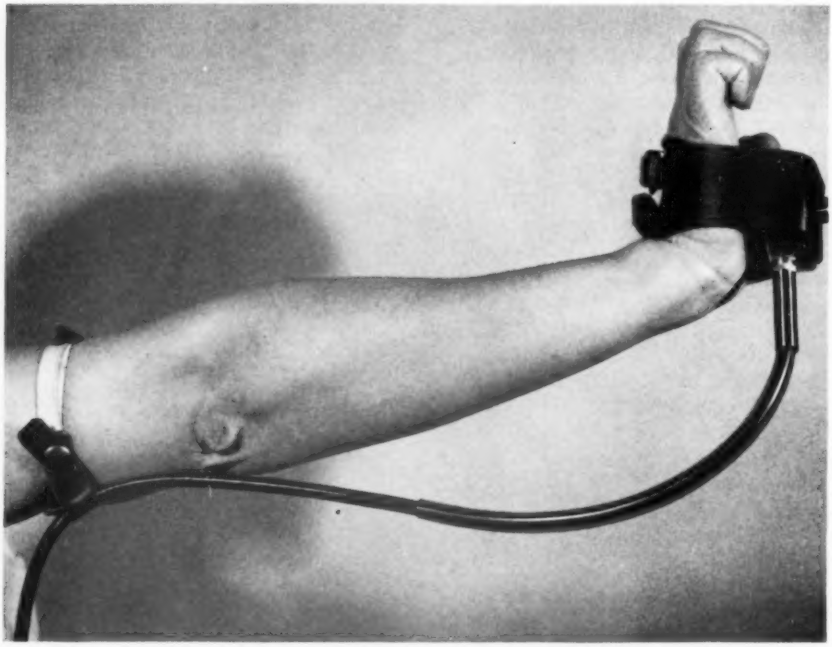

Fig. 5 — Method of wearing the manual force gage for maximum efficiency in applying force manually.

a detailed load-response characteristic for each MFG, is shown in figure 3. The weight units, which are accurate to 0.05 lb., were made in the following sizes: 0.5, 1, 2, 3, 4, 5, 10, and 20 lb. Calibration curves can be run at 0.5 lb. intervals (or greater) for any of the scale ranges from 10 to 200 lb. The projecting spokes operate a worm-screw hoist that permits removing and applying a given load slowly or rapidly during calibration runs.

A typical recording of a precision calibration record of the MFG unit is shown in figure 4. This run is for the 100 lb. scale, and load-steps are indicated for each deflection. Between successive increases in load, the weight stack is hoisted, so that at each test the recording starts from zero. The deflection marked CAL is the electronic calibration reference, which provides the means for maintaining the primary calibration during routine testing. The deflection *B* is a 3 per cent mechanical offset on the GE recorder, which compensates for nonlinearity of this instrument. Note that

in this run the over-all performance between primary load and tape recording does not deviate more than 1 per cent of full scale at any point.

The MFG unit itself, independent of the other equipment, gives linear stress-strain calibration with departure no greater than 1 per cent of full scale on any scale throughout the range from 5 to 200 lb. load. The toe of the calibration curve at loads less than 5 lb. shows deviation from linearity of variable magnitude on some MFG units as constructed and assembled, ranging from 2 to 3 per cent of full scale (10 lb.), or an actual error on this scale of 0.2 to 0.3 lb. For some precision tests on weakened actions, this error is of sufficient magnitude that appropriate corrections for measurements must be made by means of calibrations run at 0.1 lb. steps on the 10 lb. range. This characteristic is stable for a given unit after hazing, however, so that degree of error is known and subject to correction for 1 per cent accuracy by reference to the calibration curve. Otherwise, one needs to maintain a calibration check only for some fixed load on the MFG, which is a great convenience in maintaining a routine testing schedule. Usually, a 10 lb. weight is used for this purpose, and the electronic calibration thus established becomes the reference for all other scale ranges.

For maximum efficiency in applying force, an examiner wears this unit against the heel of the hand, while holding the wrist in 60 to 75 degree extension, as illustrated in figure 5. The MFG is held in place by a suitable soft leather strap, through which the load shaft projects. In muscle testing procedure, the central axis of the load shaft is applied at a right angle to the axis of the body segment. Acceptable method requires also that this relation be maintained throughout the arc of the test motion. This achieves a "tangent force reaction" as the factor measured.

Axial load is applied to a body segment of the subject through the medium of one or another pressure distributing plate. There are some 14 of these plates, which are shaped to assume stable surface orientation on the numerous body contours encountered in testing. A variety of these plates is shown in figure 6. The examiner selects one best suited to the size and contour of a body segment, so that the force of the axial load is distributed evenly over a sufficient area to reduce the contact pressure in pounds per square inch (psi) to a small value. At no time does the subject feel localized sharp pain due to a concentrated high level force at the site where the test load is applied.

Each pressure plate is padded on one side with hair felt and soft leather. On the outer surface a rectangular, hard-tempered fiber piece is fastened. This piece, which measures ¾" by 1" by

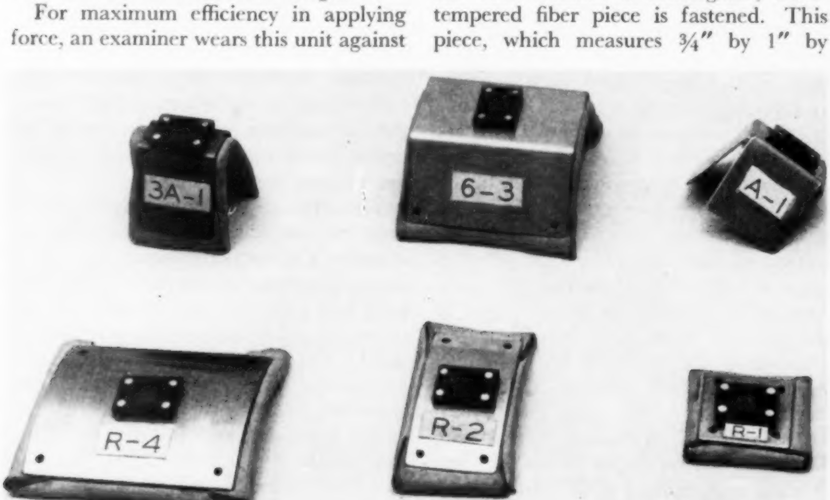

Fig. 6 — Examples of pressure distributing plates used with the manual force gage (MFG).

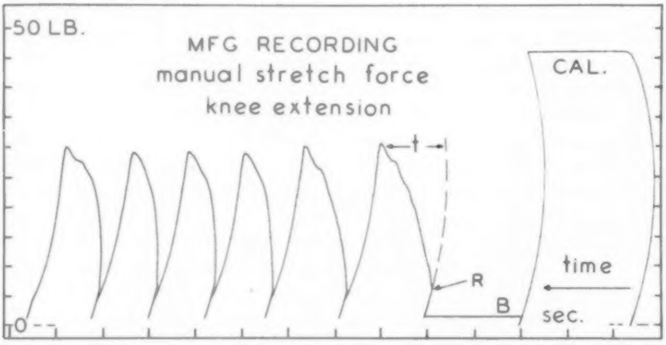

Fig. 7 — Typical manual stretch force (MSF) recording as obtained by a skilled examiner in six successive trials.

3/16″, has a circular groove ½″ in diameter and 3/32″ deep located in the center. In use, this circular groove receives the load shaft of the MFG with a loose fit. The purpose of this mechanical decoupling between pressure plate and load cell is to provide a situation that automatically requires the examiner to maintain perpendicularity between the central axis of the MFG cell and the effective radius of motion of the body segment throughout the period of the test motion. Departure by as much as 10 degrees from perpendicularity results in loss of contact, and the load shaft slips out of the fiber receptacle, promptly interrupting the "erroneous" trial. Until sufficient experience and skill are achieved, there are many such "interrupted" trials. This is far better, however, than taking biased measurements and not knowing the source and amount of error contingent upon deviations from tangential component of force.

Although the method presents difficulty to the novice, reasonably dexterous examiners master the technic in a few weeks, so that the procedure becomes quite natural without special attention. The MFG becomes, as it were, part of the natural hand. The experience of learning to use the MFG has a parallel in learning to walk on stilts. To be sure, there are some who lack the natural talent required to master the method. But such is inevitable when we are dealing with human skills. Administratively, one may gain some satisfaction from knowing that when a technician is exposed to the opportunity for learning the method, the outcome of measured performance demonstrates objectively and unambiguously whether the necessary skill exists.

In conducting a muscle test with this unit, the examiner, when working for maximum force, requires the subject to contract maximally and attempts to apply sufficient counter-force to stretch the contracting muscles through about 15 degrees of arc as judged by the examiner. This technic is called the manual stretch force (MSF) test. The curve traced on the recorder tape during an MSF test (fig. 7) combines the level of voluntary contraction with whatever degree of myotatic reinforcement is added, and there is usually some. The faster the test is given, the greater the amount of myotatic reinforcement, within determinable limits. In the recorded MSF curve, the effects from these two sources of motor innervation are summed, so that the two are indistinguishable.

This type of recording gives limited knowledge regarding the potentialities of a patient's motor performance, since only the maximum instantaneous force is measured with certainty, and this includes the unknown amount of myotatic reinforcement. The form of the recorded curve has no real significance since it combines muscular effort of the subject with that of the examiner, and one does not have any means for differentiating the two in this recording. Nevertheless, the method closely imitates the condition of testing used in clinical manual grading,

and hence serves a useful purpose of evaluating this latter method against other independent methods, which are not subject to influence by the examiner's own muscular performance against that of the patient.

From the viewpoint of detailed evaluation of muscular response and recording characteristics of motor performance of interest to physiology, neurology, and physical medicine, it is essential to distinguish between the motor tensive forces due to voluntary innervation and those resulting from activation of the stretch afferents through muscle stretching, and evaluating the behavior of each separately and in relation to each other. This is accomplished readily by methods developed through using the axial tensiometer gage, which will be described.

One essential point to keep in mind is that when using the MFG methods we are able to put into quantitative terms just what examiners actually accomplish with manual muscle testing, so that objective evaluations may replace *argumentum ad hominem* fallacies, and judgments can be tested by impersonal, scientific criteria for acceptance or rejection. Through the total varieties of methods made available through this investigation, the examiner himself can be evaluated as an instrument of precision, and with somewhat the same objectivity and accuracy as when a voltmeter with unknown characteristics is calibrated. From some of the studies, certain results lend support to the view that some examiners have an acceptable precision for some actions through restricted ranges. The same examiners make gross errors on other judgments. And so on to a multiplicity of particulars. Eventually, individuals or groups will be obliged to give attention to the question of how much error is acceptable for "clinical" and other purposes. It is likely, for instance, that an orthopedic surgeon may require a higher level of accuracy on some estimations preparatory to complex surgery than a physiatrist may consider necessary in relation to an exercise or physical therapy prescription.

Purpose of the Axial Tensiometer Gage (ATG) Method

The load cell, which was named an axial tensiometer gage (ATG), satisfies the need for a force-sensing device to be used in strictly objective recordings of muscular tensive forces through their action on skeletal segments by methods that exclude interaction between an examiner's and a subject's muscular efforts. The unit to be described here is the final design, which resulted from sequential experimental studies in much the same manner as for the MFG. The ATG was designed and constructed before the MFG unit, and was used all along in the experimental studies as a criterion for estimating the validity of results that were being obtained with the MFG methods.

The ATG is called an "axial" gage because it is sensitive to tension through the longitudinal axis of the bar on which the strain gages are cemented. The design is specifically adapted to coupling requirements, which depend entirely upon methods developed for measuring tensive and myotatic forces of the various muscular actions. The initial design in 1945 was patterned after the mechanical engineer's "proving ring" principle. From a purely engineering point of view, the proving ring design functions well for mechanical tests, but it was found to be poorly adapted to a variety of requirements implicit in muscle testing procedures. Hence, a variety of other design approaches were explored and the one finally adopted has proved to be entirely satisfactory in all respects for muscle testing procedures.

The main functional parts of the ATG comprise the gage mounting unit, cable terminal strap, dummy gage mount, cable entrance tunnel, cable protection sleeve, cover shell, and mechanical coupling recesses, as illustrated in figure 8.

The gage mounting unit is milled from 24-ST duralumin solid round stock 1⅜″ in diameter by 3″ long and is retained as one solid piece. In final form, there is a base end and a collar end, the two being interconnected by a gage mounting bar 1½″ long. To provide the full range of sensitivity required, two ATG units are

used. They differ from each other only in the cross-section dimensions of the gage mounting bar, and the assembly of active and inactive gages.

In the unit designated ATG-1, which has a load range from 0.1 to 500 lb., the gage mounting bar is 0.045″ by 0.45″ cross-section. On this bar, four Baldwin type SR-4, ABD-11, 120-ohm bakelite strain gages are cemented. Two are oriented with the long axis of the gages parallel to the long axis of the bar; the other two are at a right angle to this axis. Thus, under tensive load all four gages are active, two in tension and two in compression. The two gages that are subject to compression with elongation of the bar under axial tension contribute approximately 30 per cent additional output from the transducer bridge circuit. This corresponds to Poisson's ratio for duralumin.

The unit designated as ATG-10 is nearly one-tenth as sensitive as ATG-1, or has a load range from 1 to 5000 lb. The dimensions and arrangements of

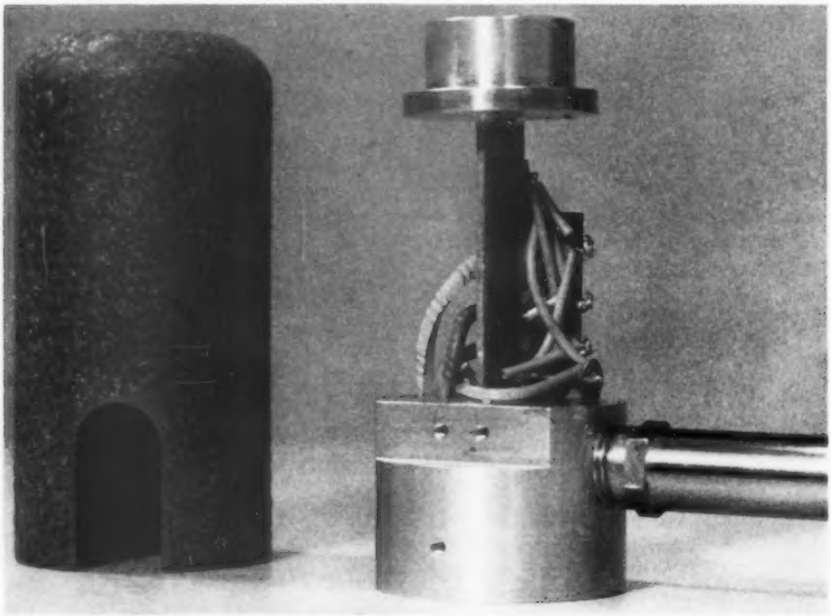

Fig. 8 — The axial tensiometer gage (ATG) with cover shell removed, showing internal construction.

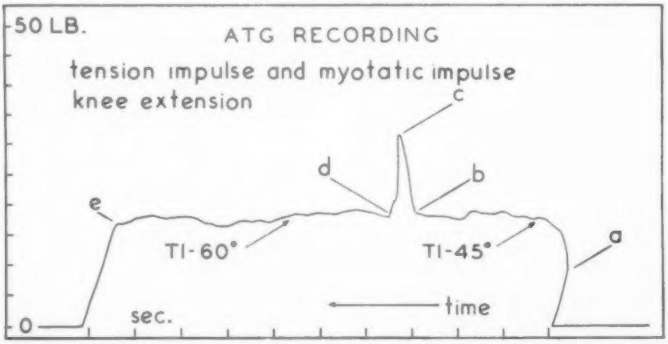

Fig. 9 — Example of recording by axial tensiometer gage method, showing isometric tension and the transient myotatic reflex response superimposed (explained in text).

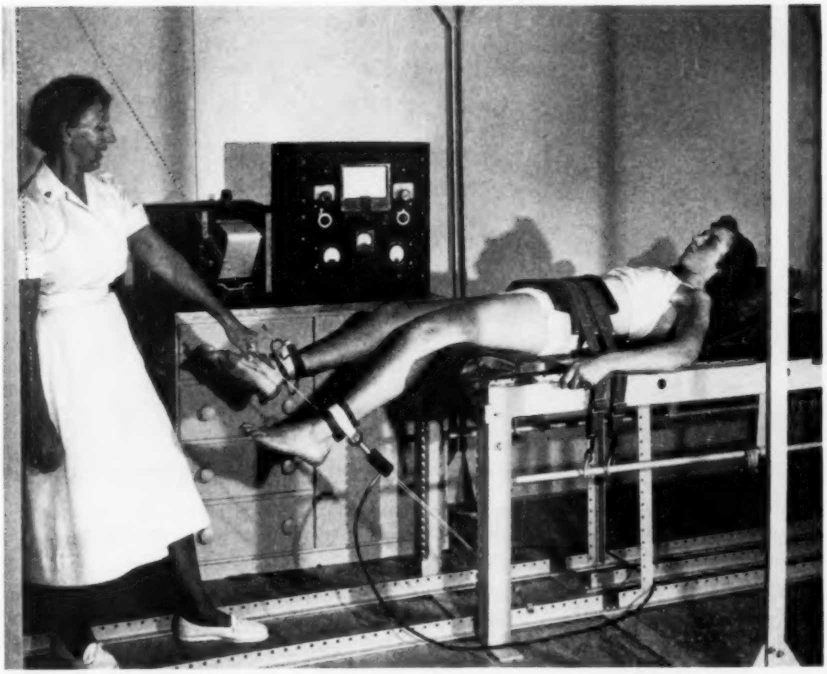

Fig. 10 — Axial tensiometer gage method for measuring isometric tension and myotatic reflex transient forces for knee extension in the 45 to 60 degree arc.

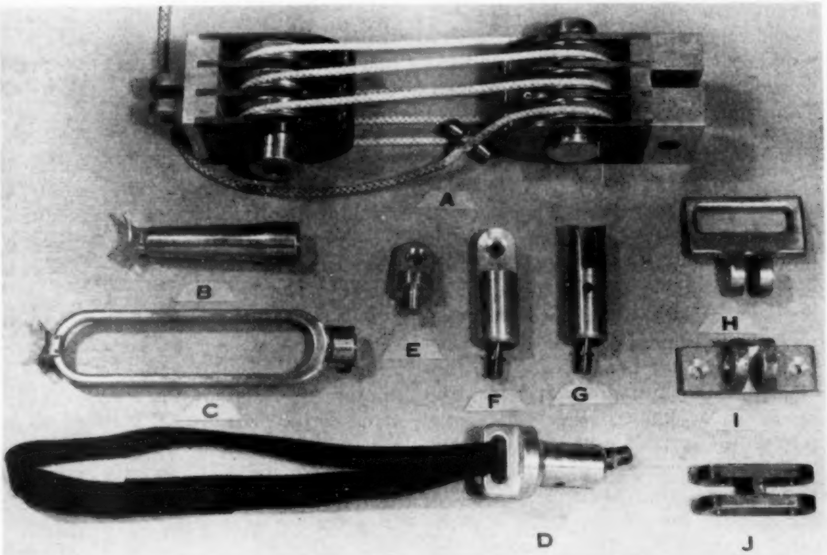

Fig. 11 — Examples of mechanical couplings used with the load cells in various muscle testing procedures (explained in text).

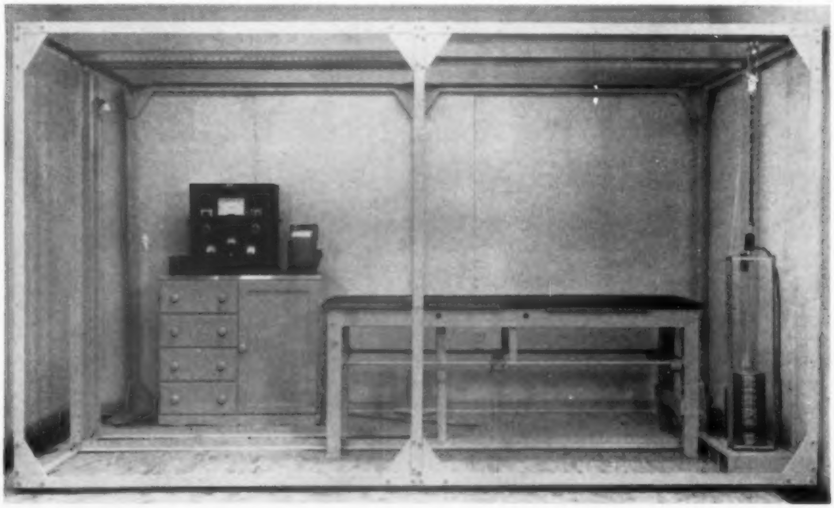

Fig. 12 — Anchorage rack and positioning table. An earlier model (1947) of Beasley's electronic myodynagraph is seen to the left, and the tensiometer calibration rack to the right.

gages in ATG-10 were experimentally derived to accomplish this easily managed decimal multiplier with only slight adjustment of the EMD amplifier gain. The gage mounting bar is 0.09″ x 0.625″ in cross-section, mounting two Baldwin type SR-4, A-5, 120-ohm paper base strain gages with their long axis parallel to the longitudinal axis of the mounting bar. Two compensating gages are mounted on a dummy plate, which is bolted securely to the base of the gage mounting unit. Thus, only two gages are active under tension in this unit, but all four are subject to the same ambient temperature, a provision that contributes to stability and low temperature drift.

Considerations relative to mechanical protection of the four-conductor extension cable were essentially the same for the ATG and MFG units. In the ATG the cable is brought in through a tunnel in the side of the base, leaving the ends of the gage mounting unit free for axial mechanical couplings. The cable leads connect to the strain gage leads at lugs in a rigid fiber terminal strip. The O-ring arrangement, which tightens the cable at the entrance hole in the MFG, is duplicated in the ATG. The extension cable can be subjected to rigorous bending and manipulation without producing tension on the strain gage leads, a consideration of decided practical importance.

A mechanically strong cover shell, made of Synthane plastic, fits over the entire unit and is bolted to the base, as seen in figure 1. The form and dimensions of the cover shell match the collar end of the gage mounting unit to keep out dust, prevent extreme bending stresses on the gage mounting strap, and allow enough clearance for maximum elongation of the strap under load. At each end of the ATG unit is a hole ⅜″ deep, threaded to receive 5/16″ x No. 18 machine screws. Various mechanical couplings are applied at these points as required by particular testing procedures. The ATG unit on the whole is thoroughly adapted to the rugged use to which it is incidentally subjected.

The ATG is calibrated by suspended axial loads composed of the same standard weights as are used for the MFG. A convenient rack, shown in the lower right hand corner of figure 12, is employed in stacking the weights. A calibration recording for the ATG appears exactly as the one shown for an MFG calibration in figure 4. In general, the ATG units yield uniformly more strictly linear load-response calibration characteristics than the MFG units on all scales for which

they are used. The ATG also has a much longer range of linear response, due to the method of applying stress to the gage mounting bar. This feature makes possible the large number of scale ranges for the ATG units, as listed previously.

The form of the isometric tension curve and myotatic reinforcement response, as recorded with the ATG method, has functional significance since muscular tensive force of the subject only determines the form of the curve. An illustration of the way one can distinguish between the force level of voluntary innervation and the additive myotatic reinforcement due to stretching contracted muscle is shown in figure 9. This example is chosen to illustrate the principle involved, with no assumption that it represents a "typical" or most frequently encountered pattern.

The following details explain the method of procedure and identify the sequence of events shown in the recording. The action is knee extension. The subject for whom this record was made is a postconvalescent poliomyelitis patient, with a manual grade of fair-plus for the muscular action tested. The position was semisupine lying, with the leg over end of table, and pelvic strap stabilization, as illustrated in figure 10. For this test, the knee was flexed to an angle of 45 degrees. The ATG is attached to a padded cuff on the subject's leg near the ankle, and a ⅛" flexible steel cable is led off at an angle of 90 degrees to the tibia. The cable is looped through a pulley and brought out for ease of control by the examiner. For such weak muscular action, the examiner does not require mechanical advantage in the pulley system. Two stops are arranged on the cable to restrict range of motion to 15 degrees. During the test, the subject is required to extend the knee with maximum effort. The first stop on the cable establishes unyielding resistance to the subject during the first phase of the trial at the 45 degree position. While this tension (voluntary effort) is being maintained, the examiner pulls the cable to the second stop, holding it there firmly until the end of the trial period.

The length of the trial is 10 seconds, which is controlled by a metronome. The examiner calls the count out loud, and tells the subject when to stop by a sharp command. The stretch is applied at approximately 3 to 4 seconds after the beginning of the trial. Throughout the 10-second period, the subject simply exerts maximum effort continuously, and the recording reflects the total tension against the ATG. The only participation of the examiner that may affect the recording is at the moment of the stretch. The ATG reacts to the total tension on the axis. Since the force applied by the subject is a reaction against the tension line at the opposite side of the ATG, the examiner's influence is merely in determining the time duration of the applied stretch, and making sure that this applied force exceeds that of the subject. This latter is arranged mechanically, so that there is never any question about adequacy of the examiner's applied force. The time duration of the stretch can be read from the record tape and, hence, can be evaluated. Otherwise, the record reflects solely the tension developed by the muscles causing rotation in the extensor direction at the knee joint.

The events as indicated by letters on the record in figure 9 are as follows: *a*, recorder relay closes, starting motion of record tape; *a* to *b*, 3-second period during which patient maintains maximum voluntary effort at the 45 degree position, producing isometric tensive force at an average level of 18 lb.; *b* to *c*, time duration of 0.32 seconds, during which examiner stretches contracting muscles through 15 degree arc of knee joint, and a transient response rising by an increment of 13.5 lb. greater than the level of voluntary innervation, or to a maximum instantaneous value of 31.5 lb.; *c* to *d*, period of rapid inhibitory reaction lasting only 0.17 seconds, or about half the time of the positive myotatic response; at point *c* the second stop is reached, the cable is held taut, and from then on all characteristics of the recorded curve reflect solely the tensive responses of the subject; *d* to *e*, period of approximately 6 seconds, during which subject maintains maximum voluntary effort at the 60 degree position; *e*, end of trial and subject relaxes voluntarily.

Accessory Equipment

The specific utility of each item in the rather diverse assortment of accessory equipment as used in the complete system of methods for both normal and pathologic neuromuscular conditions can be described most appropriately and clearly in context with reports on specific experimental procedures and results. This objective constitutes part of the plans in a series of papers now in preparation for future publication. Only a brief description of certain basic equipment is given here to indicate the essential nature of requirements for methods that have given the most satisfactory results.

Numerous coupling attachments may be applied to the ATG, depending on the testing method and force levels involved. The facility provided in the ATG design, permitting rapid exchange of the end-couplings, multiplies the usefulness of these units. Materials used in coupling lines between the subject's body segment and a fixed anchorage include webbed straps, nylon cord, super-flexible steel cable of various sizes, link chain of different gages, and roller chain. Suitable mechanical units for attaching each type of coupling line to the ATG, to the fixed anchorage points, and to the patient's body segments were custom built. Precautions to avoid pressure pain to the subject are observed always, for when such pain is present the object of the test is nullified. Oftentimes the threshold of pain, not the maximum contractile force of muscles, is the factor measured in a quantitative muscle test. The examiner must be alert to this possibility at all times.

A few of the couplings employed with the load cells are shown in figure 11, as follows: *A*, this specially designed ball-bearing block and tackle unit, giving mechanical advantage of 6:1, is used to aid the examiner in applying stretching force to stronger muscle groups, when the latter are in a state of voluntary contraction; *B* and *C* are special probes attached to the MFG load shaft for applying force conveniently to fingers and toes, when a detailed examination is required; *D* is a special coupling with a fixed leather loop, narrow or wide as occasion requires, and provides the means for conducting muscle tests in the manner developed by Martin, excepting that in this adaptation of his method, the force reaction curve is recorded; *E* is a fixed eyelet, screwed into either end of the ATG, and connects into either *H*, which is a belt-loop coupling, or *I*, which is fastened to some fixed surface; *F* and *G* are ball-and-socket toggles, having a conical angle of 20 degrees freedom in all directions around its central axis, to prevent distortion on the ATG during application of axial tension; *J* is an intermediate coupling having many uses.

Nearly every method of testing requires some form of artificial stabilization and counterpoise assistance to the subject. The specific arrangements are too numerous to describe here, but it is always essential to consider where, anatomically, the major stresses will occur in a given testing arrangement, and to provide suitable support or assistance to those loci, so that this source of bias does not invalidate an intended measurement on a primary joint motion. The need for stabilizers is not at all limited to measurement of strong actions in normal subjects. The need is fully as necessary, if not more so, for well-controlled measurements on patients with various patterns and degrees of paresis, and other neuromuscular dysfunctions.

A special table, 26″ wide and 78″ long, with facilities for fastening various assistive devices was constructed. The table top is padded with hair felt and covered with Naugahyde, giving a firm but sufficiently comfortable surface. Too much comfort, such as a thick, yielding foam rubber surface, defeats the objective in most quantitative tests, and actually is not necessary. For an exercise table the considerations are different, and the nature of the upholstering is not so critical. In the present system, it is frequently necessary to control joint angles and other body positioning in relation to the biomechanical factors being evaluated. This necessitates non-yielding but comfortable surfaces. The varieties of mechanical stabilizers utilized include padded straps, padded cuffs with attached cables or link chain, padded

blocks shaped to give equalized pressure against the body area where applied, foot-pressure surface, padded extension shelves, padded back pressure surface with adjustable angle, and others.

Some have indicated that such an array of physical equipment unduly complicates muscle testing procedures. The answer to this sort of negative criticism is strictly objective, quantitative, and kinesiological. Properly applied stabilization is indispensable to measuring the full force of primary actions and to relieve stresses, which frequently are painful in themselves, in joints and segments distal to the action being measured.

An arrangement whereby tension lines can be coupled between a fixed and stable anchorage point and the various body segments is essential. The testing table, in general, is the reference point for either a patient or a normal subject. However, forces of many actions can be measured more effectively with the subject in positions other than lying — whether prone, supine or side. Nevertheless even when some other positioning is employed, the table surface often remains the most useful reference point. Tension lines are needed in all possible directions and angles — up, down, laterally and longitudinally. The most direct and complete solution to this requirement is a strong frame surrounding the table. Such an arrangement was finally constructed for the present system, after many makeshift compromises had proved to be unsatisfactory.

The frame is 6′ 7″ wide, and 12′ long, and 6′ 9″ high. It is constructed of 1/4″ by 2″ angle irons and T-bars, with strong corner and midside brackets and cross-braces. The bottom framework is bolted to a 5/8″ thick plywood false floor, covered with linoleum. A system of movable cross-T-bars, drilled at standard lengths, can be placed at any required position across the top or bottom, and along the sides of the frame. A row of holes, 5/16″ diameter and spaced 1 1/2″ on centers, is drilled along the spine of each T-bar. This provides a standard arrangement for attaching the various mechanical couplings for tension lines and pulley systems required in the different ATG testing procedures. The flexibility of the arrangement permits wide latitude for experimental exploration of new methods, which perpetually occurred in the course of this investigation.

Industrial Placement of the Physically Handicapped

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In order to discuss the part that industry plays in rehabilitation of injured workers, it might be advisable to give a brief explanation of the scope of industrial medicine. Industrial medicine is the theory and practice of medicine in relation to the health of the working people. Fundamentally it is preventive medicine. Its basic function is health maintenance. Its object is to furnish employees with the best possible health protection consistent with the purpose of industry, which is manufacturing; the employer's responsibility as fixed by law, which is the prevention and care of occupational injuries and diseases; and the employee's right of free choice of physician in the care of sickness and injuries not legally related to occupation. Industrial medicine comprises several functions: Industrial hygiene, health maintenance, and therapy and rehabilitation.

Industrial Hygiene

The physician is the health officer of the plant. His function is to advise and assist management in the control of occupational diseases and environmental factors that may have an effect on health.

The specific studies in industrial hygiene are usually done by an industrial hygienist. The proper control of industrial exposures is the keynote to the prevention of occupational diseases. For the purpose of brevity, all industrial sources of diseases are termed "exposures."

The first step toward control is to identify the material, or conditions that are capable of causing disease. These may be found in working conditions and environments — in the processes, operations, methods, substances, or materials intrinsic to manufacturing. They are usually in the form of dust, mists, vapors, fumes, gasses, and fluids. Having identified exposures, it is the doctor's duty to determine their potential as a source of disease and to direct the management's attention to the need of control measures, thus simplifying the problem of prevention. The doctor and his staff should study the methods of manufacturing, the materials used, and the general plant conditions in order that he might anticipate possible diseases and make suggestions. Working in cooperation, the toxicologist determines the source of disease; the engineer, the nature and extent of exposures; the doctor, the nature and extent of effects. All endeavor to evolve an industrial program of maintaining more healthful conditions for the workman and of promoting general efficiency.

After the sources and the relative importance of exposures are determined, control is the problem. This is accomplished by substitution of harmless materials, if possible; changes in processing and manufacturing; capture of dust, fumes, mists, vapors and gases at their sources, or segregation of operations in which capture is not feasible; use of respiratory protective devices, when safe limits of air contamination are necessarily exceeded; and use of protective creams and suitable gloves and clothing if skin is exposed. The prevalence of exposures such as dusts and fumes makes the control largely a mechanical problem, thus giving rise to the designation of the present period in industrial medicine as one of "engineering control."

Periodic plant inspections by the physician are advisable to observe the changing conditions, methods, and processes so that he can seek out sources of disease and assure himself that the protective equipment and devices are operating efficiently and being used intelligently. In most plants it is the duty of the safety department and the supervision to investigate and to report any suspected exposures. The problem of en-

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forcement of the established program is also that of the safety department and the supervision. The workman must receive suitable instructions and have watchful supervision. The foreman must take the necessary time to instruct the workmen properly and to insist that they use the prescribed protective devices. A successful program depends largely on the cooperation of the supervision.

Layouts or facilities should be practical and built with a functional design to encourage efficient operation, but the building does not make the man — the man and the service make the building.

Therapy

The therapeutic functions of the physician in industry are necessarily limited to the care of occupational injuries and diseases, the temporary care of minor nonoccupational ailments, and first aid in nonoccupational emergencies. In handling these conditions he practices conventional medicine and surgery and, as such, his practices and procedures need not be discussed at this time; however, the important aspect of his practice in the plant lies in his ability or courage to discriminate between the conditions he should and should not treat. He must not assume the function of the physicians in private practice.

Health Examination

A sound examination plan is the basis for a good health maintenance program. No industrial medical program would be complete without an adequate program of rehabilitation. Rehabilitation may be defined as the return of a person disabled by accident or disease to his greatest physical, mental, emotional, social, and economic usefulness, and, if employable, an opportunity for gainful employment. Rehabilitation cannot be readily accomplished unless the industrial medical program has a good placement plan. The employability of all persons depends on the emphasis placed on the individual's ability, rather than on the disability. Few persons, if any, are physically perfect. Most people have some deviation from normal that may affect their manner of living or working. The defect may be very minor in nature; it may be of a type that has little or no effect upon the individual's capacity to perform work. A good example of this is an individual with a speech defect assigned to the operation of a machine in a factory. The defect has no bearing on the individual's ability to perform his job; however, if this same individual were assigned to work that required him to meet the public and answer questions, his speech defect would be a definite handicap. The average person with an abnormality that presents no problem on his job probably has never considered himself physically handicapped.

Selective job placement is the keynote to the effective use of manpower. The ideal use of manpower is impossible because of the human variance of man. Machines, tools, jigs, and fixtures are ordered to specifications, and these machines are expected to perform to known limitations. Since manpower cannot be ordered to specifications, available manpower must be utilized to the highest degree of efficiency. If we are to succeed in the utilization of manpower, we must be prepared to use all known means to determine man's probable success on a given job. The industrial physician may play an important role in the utilization of manpower.

Job placement is founded primarily on two basic principles: first, the physical requirements of the job; and second, the physical capacity of the individual. The first principle can be determined by a thorough job analysis, or by using the supervisor's knowledge in evaluating the job at the time of each placement. The latter can be determined only by a good medical examination. The medical examination is the basis of all programs of job placement. By means of this examination, an evaluation of the individual's physical ability and disability is used to determine his capacity to perform work. The examination is made with four points in mind: medical history, physical examination, laboratory studies including x-ray, and personality study, or evaluation of emotional stability. One should look upon this examination as a

square with equal importance placed on each side of the square. Too frequently, triangular examinations are made with attention paid only to the first three points. Objectives of the physical examination are: To acquaint the worker with his physical status; to call attention to physical abnormalities that should be corrected; and to stimulate in him the responsibility for the maintenance of his health. The health and safety of others is safeguarded by excluding those physically unfit to work or those with communicable disease. A record of the individual's condition is established at the time of employment with particular reference to existing handicaps, disabilities, or limitations. Placement and advancement of workers in accordance with the individual's physical and mental fitness is also facilitated.

In order to be successful, any placement program must have the complete cooperation between the employment department, medical department and all the supervisors in the plant. The physician, knowing the physical condition of the individual, will endeavor to evaluate properly that physical condition and to approve the employee for all types of work or to restrict him in a way that will limit him to work that is in keeping with his physical handicaps. The supervisor, informed of this limitation, will evaluate the work and will endeavor to place the individual on work that is commensurate with the individual's physical ability.

By means of this examination, the individual may be classified as follows:

Group 1 — Unlimited: Acceptable for any type of work in any department.

Group 2 — Limited: A physical handicap or defect exists that may limit an individual's working ability, constitute a hazard at work, or be seriously aggravated by certain types of work. An individual classified as "limited" is placed in one or more of the following classes, which are intended to describe in lay terms to the department supervisor the type of work that the employee should avoid. The reason for the limitation is, of course, a confidential matter between the patient and the physician. It is of no practical interest to the supervisor as long as he is informed in regard to the restriction placed on the employee. Under group 2 there are seven classes:

Class 1. No hazardous machinery: Primarily individuals with serious visual defects, diabetes, heart disease, or hand and arm disabilities, which increase the hazard when working on such operations as milling machines, grinders, lathes, and power saws.

Class 2. No heavy lifting: This is given in a limited number of pounds. Individuals with various disabilities such as old back injuries, deformities, and hernias. Light weight men and all women are placed in this category.

Class 3. Ground level work: Individuals susceptible to dizzy spells from any cause or having deformities or limitations of the extremities.

Class 4. Avoid dust and fumes: Individuals with chronic bronchial conditions.

Class 5. Avoid skin irritants: Individuals who are subsequently found to be sensitive to such substances as oil.

Class 6. No extensive walking or standing: Individuals with certain types of back injuries, varicose veins, lower extremity disabilities, heart disease, and similar conditions.

Class 7. Restrict to relatively noise-free areas: Individuals with conditions involving the auditory system or the general nervous system.

Group 3 — Individuals with a severe handicap that requires special attention for safe placement. They must be placed on a special type of work and remain on that particular job until a special placement is considered in changing them from one job to another.

Group 4 — Temporarily unable to work because of a physical condition: This group includes those with transitory conditions that respond to treatment or who have remedial defects that should be corrected before placing them at work.

Group 5 — Rejected: Not suited to be placed at factory work.

It has definitely been shown that good placement means better efficiency, shorter training time, improved worker's interest and enthusiasm toward the job,

better employee satisfaction and morale, better job adjustment, decreased accidents, reduced absenteeism, and decreased labor turnover. All of these reflect in the reduction of operating costs.

Many employers fail to employ handicapped individuals because they lack an effective placement program. Others are reluctant to employ handicapped individuals because of some unfortunate previous experience. Some employers believe that they are asked to assume an undue liability in the form of potential compensation risks. The compensation laws of most states compel the employer to accept the handicapped and the nonhandicapped with equal liability. Most employers recognize the fact that a certain percentage of handicapped individuals may be used without impairing the over-all efficiency; however, the percentage of handicapped workers in any one department should not become too high or it will limit the flexibility and efficiency of the working force, especially in heavy industries or those that require special skill.

In some companies, the employer is governed in the employment of handicapped individuals by contracts with unions. Some collective bargaining contracts exclude the handicapped by requiring all new employees to start their employment on a heavy laboring job and progress to more skillful jobs in line with seniority. Other contracts have such tight clauses governing the noninterchangeable occupational groups that it practically prevents the employment of handicapped individuals. Obviously, labor and management should take a new look at such provisions and modify them so that a handicapped worker will not be barred automatically from earning a livelihood and contributing his share in the nation's production.

Preplacement and periodic examinations are used for placement purposes as well as for advising workers in regard to health problems that need attention. These examinations can be used for detection of various diseases such as tuberculosis and heart disease. Some industries have incorporated fairly complete heart studies with routine electrocardiograms. Others only do electrocardiograms in selected cases or selected age groups. It has been found to be of great value to run routine EKG's on all patients or at least those over 40. This study is of great value as a base line for future reference in case of need for comparison. Our clinical findings have been of the greatest assistance in placing cardiac patients on the job.

Case Reports

The following case histories are cited briefly to illustrate how successful placement can be when individuals are placed at work that they can perform efficiently and effectively.

A man who lost his left hand at the wrist and the first three fingers of his right hand became so despondent that he threatened suicide on several occasions. We discovered that his favorite hobby was playing pinochle, but with the loss of his hands he was unable to hold the cards and could no longer participate in his favorite pastime. The patient was taught to use his thumb and little finger to grasp the cards from a specially made rack. After several weeks of encouragement he finally started to play pinochle with his friends. This started him on the road to recovery. The next obstacle was his inability to handle coins, thus he could not ride public transportation. A great deal of time was spent training him to use his thumb and little finger in handling coins from his pocket so that he could drop them in the coin box on the street car and busses. When he developed confidence he returned to work. He was placed on a special elevator which he could operate safely and efficiently. This man had a new outlook on life because he was working and self-supporting. To date he has had no trouble and his attendance has been one of the most outstanding in his entire department.

An applicant for a job as a power house engineer had aortic stenosis. The first impulse was to reject him because of his heart condition; however, when the job requirements were analyzed and this man's physical capacity was fully evaluated, it was decided to place him at

work as an engineer. To date he has handled his job very efficiently and has not missed a day from work due to illness.

A man who has worked for 30 years in the engineering department advanced from a junior clerk to supervisor of engineering specifications in spite of a deformity of his right leg and spine resulting from osteomyelitis during childhood. An employee who has worked continuously for 27 years in an office has established an outstanding record for attendance and has received several promotions in spite of a marked deformity of both legs and his back as a result of poliomyelitis at age 5. A man with 10 years' service as an outstanding employee has worked as a repairman in spite of the fact that he lost his hearing at age 3 and his ability to speak is practically nil. Another man has a congenital deformity of his left leg and foot with 4 inches shortening. He was able to work as a crane operator for over 20 years. After he had a heart attack it was necessary to remove him as a crane operator. He was placed on a job as a bench assembler on very small parts. This is a full-time sitting down job which he is able to perform without jeopardizing his heart condition.

No problem exists if the job demands are in balance with the individual's capacity to perform work. A successfully placed handicapped worker ceases to be handicapped from the standpoint of earnings or productivity; however, one problem that confronts us continuously is how to measure the individual's ambition or desire to work. To the best of my knowledge, no valid test accurately measures this factor. Fortunately, most handicapped individuals with a definite abnormality have a very sincere desire to work and are usually ambitious, but many individuals try to use minor conditions as a means of avoiding work. These individuals make it extremely difficult for the handicapped who have a real desire to work.

Summary

Industrial health service is responsible for the protection of working people against possible sources of disease in the plants, their safe placement, the subsequent supervision of their health in relation to employment, and the treatment of conditions that result from occupation. It is the plant doctor's privilege and duty to cooperate with the general profession and departments of health in their respective efforts to treat and reduce general sickness. Industrial medicine, general practice, and public health are complemental. To conserve human values is their common purpose.

NATIONAL BIOPHYSICS CONFERENCE

A steering committee of some fifty scientists, representing various aspects of biophysical research in this country has organized a national biophysics conference to take place in Columbus, Ohio from March 4-6, 1957. The conference will encompass studies which employ the approach of physics in biological measurement and theory, at levels of organization from molecules and cells to complex systems and psychophysics.

The program is expected to include twelve invited papers related to different biophysical fields and a large number of contributed papers. Scientists with biophysical interests may write to Dr. Herman P. Schwan for further details and information on presenting contributed papers.

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Components of a Rehabilitation Center

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The term rehabilitation center is one that has been used broadly and loosely to describe quite a variety of facilities. Before the components of a rehabilitation center can be discussed it is necessary to know just what one is. Many people have worked on definitions. About two years ago the Conference of Rehabilitation Centers drafted a definition that placed the emphasis on a variety of services in a center — medical, social, vocational, psychological — and placed the center in the role of assuming responsibility for a full-scale program of integrated and intensive services, but did not necessarily require all the services to be given in the center.

Last year when the amendments to the Hospital Construction (Hill-Burton) Act (P. L. 482, 83rd Congress) were being drafted, it was necessary for administrative reasons to have in the Act a precise definition of a rehabilitation facility. Following the line established by the Conference of Rehabilitation Centers, the law defines a center as having a twofold program, evaluation and services, in each of four basic areas — medical, psychological, social and vocational. It further stipulates that these programs shall be integrated, that the major portions of each of these services shall be offered within the center, and that medical and related health services shall be under the direction of a physician licensed to practice medicine in the state.

The Vocational Rehabilitation Amendments of 1954 (P. L. 565, 83rd Congress) contains two definitions of a rehabilitation facility. One is the same as that contained in the amended Hospital Construction Act, the other is a much simpler one which merely defines a center or a facility as one that offers one or more services. The second definition need not concern us here because it was written to enable State rehabilitation agencies to assist in the financing of a variety of facilities, not necessarily rehabilitation centers.

In the administration of the amended Hospital Construction Act certain interpretations have gained rather wide acceptance. One is that the Act is designed to assist in the construction of comprehensive centers, not centers that provide only partial service. Comprehensiveness is thought of in terms of the scope of the program and not in terms of the number of categories of disability served in the center. The emphasis on comprehensive centers in no way implies that this is the only kind of center needed. It is recognized that there is a definite need for many less comprehensive facilities, but this particular act is designed to aid in the construction of comprehensive centers only.

Another concept has to do with the kinds of patients served in the center. The centers may be multidisability, serving people who are patients in a number of different disability categories, or they may be single disability, serving patients in only one disability category. A good example is the rehabilitation center for the blind, which is comprehensive in its program and integrated in its services, but because of the special problems involved, it serves only blind patients.

Rehabilitation facilities under the Act may be in-patients, or out-patients, or both. Centers may be designed to serve adults only or children only, or both. Facilities under the Act may be set up as a part of a hospital or they may be set up separately.

An important concept is that the centers established under this Act are not limited to vocational rehabilitation clients or patients. They must be open and available to all persons who can profit from the services offered. This definitely would include older persons or children for whom no vocational objective is specifically planned.

Part of the **Symposium on Rehabilitation Centers** presented at the Thirty-third Annual Session of the American Congress of Physical Medicine and Rehabilitation, Detroit, August 31, 1955.

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The concept of major portion of services being required in the center is a difficult one to administer. It necessarily implies a listing of minimum services that must be offered within the center. In a multidisability facility the following services are required to be offered in the medical area: evaluation, medical supervision, medical consultation, physical therapy, occupational therapy, speech therapy, and psychiatric service. In the psychological area, only evaluation is required to be offered in the center. It is understood that services in this area will be conducted under psychiatric supervision when necessary. In the social area, evaluation and social case work are required within the center. In the vocational area, vocational counseling, prevocational activities, and, if children are served, special education facilities are required.

Under the Act, facilities to be approvable must offer an integrated program of service. In general these concepts govern the approvability of projects. The applicant must demonstrate in his program description how integration is to be accomplished. The part-time professional staff must be on a regular schedule including staffing time each week when all part-time and professional staff will be available for the staffing of cases. Conference room space must be provided in the building plans.

Perhaps the easiest way to summarize the concepts in rehabilitation facilities under the Act is to compare such a facility to a four-legged table. The four basic services, medical, psychological, social, and vocational, may be thought of as the legs of the table. The top is where two kinds of things are accomplished, evaluation — sorting of cases — and services — the actual work of the center. Finally, the legs and the top must be securely glued together if the table is to be a usable piece of furniture, in other words, it must be an integrated unit.

CONTINUATION COURSE IN PHYSICAL MEDICINE FOR SPECIALISTS

The University of Minnesota, in conjunction with the Elizabeth Kenny Institute, will present a continuation course in Physical Medicine for Specialists at the Center for Continuation Study from December 6 to 8, 1956. Therapeutic exercise in rehabilitation will be stressed. Guest speakers will include Dr. Willis C. Beasley, Director, Biophysics Research Laboratory, Bethesda, Maryland; Signe Brunnstrom, Consultant in Amputee Training, Institute of Physical Medicine and Rehabilitation, New York University Bellevue Medical Center, New York City; Dr. Edward E. Gordon, Director, Department of Physical Medicine, Michael Reese Hospital, Chicago; Dr. H. Harrison Clarke, Research Professor, Physical Education, University of Oregon Medical School, Eugene; and Dr. Walter J. Treanor, St. Mary's Hospital, San Francisco.

The course will be presented under the direction of Dr. Frederic J. Kottke, Professor and Head, Department of Physical Medicine and Rehabilitation.

Lodging and meal accommodations are available at the Center for Continuation Study.

Responsibilities and Functions of Physicians in the Rehabilitation Center

Ralph E. Worden, M.D.
Columbus, Ohio

During the past few decades, various groups have recognized the needs for rehabilitation of the disabled and have thus assumed the responsibility of establishing rehabilitation services. Those who have continued to assume this responsibility should be highly commended; however, each group is disciplined by its own experience, and they are all prejudiced. All groups should take the responsibility of fostering a democratic, permissive attitude and accept the philosophy that rehabilitation is everybody's business. A dominant rehabilitation service can actually produce a crippling effect on the other services.

It is impossible for a physician to provide a complete rehabilitation evaluation with recommendations solely on the basis of a medical history and a physical examination; therefore, all services in the rehabilitation program should be given their rightful stature. The democratic and permissive attitude also applies to the physician. At the present, too many administrators of rehabilitation programs have been instrumental in keeping the physician's role at the periphery of the program, which results in inadequate medical coverage. But how does the patient see himself as he enters a rehabilitation program? What are his problems as he sees them? Almost always the answer is in the medical area. If the problem is not primarily medical, at least the patient thinks so. The physician's role in answering purely a medical problem needs no discussion. However, if the patient thinks that his problem is primarily medical, when actually it is social-psychological, vocational, or economic, then the physician has the important responsibility of helping that patient adjust his thinking to accept the disability and to want aid from those services that can help him as much or more than the strictly medical services.

Every rehabilitation program should be provided with adequate medical supervision. The amount of supervision will depend on the type of rehabilitation services to which the rehabilitation program is geared. Either a full or part-time medical director should be appointed to direct all the medical services.

Additional suggestions for the physician's responsibilities were listed by those reporting on the last workshop of the Conference of Rehabilitation Centers as follows:

"Medical direction will require provision of medical diagnosis, prescription writing, supervision of medical services within the facility, co-ordination of medical consultants who render services, and responsibility of the liaison action with local medical societies and physicians.

"Medical services shall include: Physical Therapy, Occupational Therapy, and Prosthetics." [The term medical services, as here defined to include only physical rehabilitation services, is too limited.]

"Services which *require* medical *consultation* and/or participation:

(a) Speech and hearing therapy — to provide,
   1) Medical diagnostic evaluation
   2) Co-ordination of medical consultations required for diagnosis, and
   3) When medical treatment is required.

(b) Medically directed recreational therapy.

"Services which are non-medical, but in which the physician should *participate* as a team member:

a) Psychological services
b) Social services
c) Educational services
d) Vocational services

Part of the **Symposium on Rehabilitation Centers** presented at the Thirty-third Annual Session of the American Congress of Physical Medicine and Rehabilitation, Detroit, August 31, 1955.

Director, Ohio Rehabilitation Center, Ohio State University.

e) Follow-up of patients

f) Research and special studies.

"Director of Center and/or Administrator and/or Co-ordinator and/or Leader may or may not be a physician. Competence for this role or these roles is not restricted to *any* discipline and is dependent upon requisites other than a medical degree." [If the staff physician has leadership qualities, I personally feel he should assume directorship responsibilities.]

"Designation of areas of legal responsibility of the physician should be obtained from legal counsel in the local community of the rehabilitation facility. [It was felt at the time that this point was discussed that the physician may have a legal responsibility in whatever happens to the patient while in the rehabilitation center.]

"Working relationships with local physicians should be the responsibility of medical personnel of the facility. Proper relationships with local medical societies are imperative for community physician acceptance. [This represents an area of great responsibility. Services of the rehabilitation center will grow only if the community physicians understand and accept the services available. It is not enough that the referring physician receive a report about his patient from the medical director. The referring physician should be made to feel that he is part of the rehabilitation team serving an individual. He should be consulted frequently on medical matters, and certainly on any decision involving surgery. Above all, upon discharge of the patient, he should receive the final discharge note that refers the patients back to the referring physician for further medical care.]

"Medical personnel of the facility are responsible for instruction of staff on medical ethics.

"In certain facilities, i.e. hospital and/or medical school rehabilitation facilities, legal and administrative policies require a physician as chairman, director, or chief of the department. Medical educational programs have done, and will do, very much in promoting suitable environment for properly functioning rehabilitation services."

In the past, the practice of medicine has been geared to care for the acutely ill. The medical profession as a whole is beginning to appreciate the needs of the chronically ill, the disabled, and the older patients. Whether or not we catch up to the needs of these patients will remain to be seen; however, we must never cease in our efforts. As expressed by Charles Kettering: "The only time we must not fail is the last time we try."

Glossopharyngeal Breathing in the Management of the Chronic Poliomyelitic Respirator Patient

Alma J. Murphy, Ph.D.
Norman S. Talner, M.D.
and
David G. Dickinson, M D.
Ann Arbor, Mich.

Glossopharyngeal breathing (GP breathing) is a technic for ventilating the lungs that does not require the use of the muscles of respiration. Instead, the muscles of the mouth and pharynx are utilized to force air into the lungs under positive pressure. A volume of air averaging 60 cc. is trapped in the pharynx by closing the mouth and nasopharynx. The air is then forced into the trachea by the constricting action of the pharyngeal muscles and upward displacement of the tongue. The trapped air is held in the trachea and lungs by closing the laryngeal sphincter until the next volume of air is ready to be forced into the trachea. It may take 20 such maneuvers to force 1,000 cc. of air into the lungs. The laryngeal sphincter is then opened and exhalation is carried out passively by elastic recoil of the lungs.

This technic occasionally has been developed unconsciously and spontaneously by respirator patients in several areas throughout the country. It was first recognized as a useful method of respiration by Dail and his associates[1] at the Rancho Los Amigos Hospital, Hondo, California, in 1951. Dail initiated the first teaching program for GP breathing. He has emphasized its importance for increasing the ability of the respirator patient to breathe without mechanical assistance, to improve speaking volume, and as an aid in coughing.

A teaching program for GP breathing was initiated at the University of Michigan Poliomyelitis Respirator Center in 1953. In addition to the previously reported uses, the technic has been used extensively in an effort to minimize the profound loss of pulmonary and thoracic elasticity that occurs in postpoliomyelitis respiratory paralysis and probably in many chronic lung diseases as well. By greatly increasing the work of breathing, this significant loss of elasticity or pulmonary compliance, first reported by Ferris and co-workers,[2] presents a very real problem to the clinician caring for respirator patients. Many attempts have been made to minimize this loss of compliance by periodically stretching the lung and chest, utilizing exercise programs and deep breathing machines. Glossopharyngeal breathing enables patients with reduced vital capacity to inhale a far greater amount of air than is possible with any of the deep breathing machines; therefore it seemed logical to assume that GP breathing would be more effective in stretching the lungs and thorax. If stretching those structures will minimize loss of compliance, then GP breathing should be the most useful method of handling this problem. The data presented here support this view.

Instructional Program

Material and Methods: Instructions in the technic of GP breathing are made available to all respirator patients with a vital capacity too small to sustain life unassisted by mechanical aids, to all patients who are unable to produce an effective cough, and to all patients whose lungs and thorax demonstrate a loss of elasticity as measured by a pressure-ventilation study.[2] The instructions that have been given to 43 patients were essentially those described in a teaching manual by Dail and his associates.[3]

Initially, each patient was evaluated medically to determine his need for GP breathing. This was followed by a

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The Poliomyelitis Respirator Center is supported by a grant from the National Foundation for Infantile Paralysis, Inc.

detailed examination of the function and strength of the structures and muscles used in this technic. Next, the patient was prepared psychologically to gain his cooperation and acceptance of the instructions through his understanding of the purposes and benefits of GP breathing. The instructions then were presented in a simplified form as follows:

1. Open the mouth slightly and lower the back of the tongue to the floor of the mouth as in a sucking motion.
2. Close the lips and hold the air in the mouth.
3. Raise the back part of the tongue toward the soft palate while preventing the air from escaping through the nose.
4. At the same time, make a squeezing motion, similar to a swallow, in the throat so that the air from the mouth is pumped into the lungs.
5. Hold this air in the lungs, as you would if the mouth were open, before opening the mouth to repeat this maneuver.
6. In this manner, pump air into the lungs until there is a feeling of fullness in the chest.
7. Exhale passively and then quickly repeat these breathing maneuvers.

When necessary, special exercises were devised to strengthen and develop coordination of the glossopharyngeal musculature. Motion pictures of patients using GP breathing, and suggestions and demonstrations given by other patients who had experienced the advantages of a substitute breathing method, were additional teaching aids. Contests, awards, frequent testing, and continual encouragement helped to maintain the high morale necessary for a successful program.

The therapeutic program was divided into two phases. The initial phase was devoted to helping the patient attain successful and later efficient use of GP breathing. To accomplish this, the patient had to be able to accumulate a GP breath of at least 1,000 cc. within a few seconds in order to maintain an adequate minute volume of air exchange during his unassisted breathing time. During the second phase, the patient was encouraged to increase the maximum GP breath so as to increase the distensibility of the chest and effectiveness of cough, and provide adequate breath volume for talking and other activities. The program for stretching the chest consisted of six to eight maximal GP breaths (1,500 to 2,500 cc.) four to six times a day. The patient was encouraged to extend his unassisted breathing time gradually, as his general medical condition permitted.

Results: The time required to teach patients this technic varied from one day to six months. Nineteen patients learned within one week, 19 required longer periods of time, while 5 failed to inspire a maximal GP breath of 1,000 cc. Most of the patients with a vital capacity of less than 500 cc. were able to inspire between 1,000 and 2,000 cc. of air with GP breathing as compared with the majority of those patients with a greater vital capacity, who were able to inspire over 2,000 cc. of air in a maximal GP breath. Some patients, in both classifications, were able to inspire over 3,000 cc. of air. No deleterious effects were observed in these patients.

Compliance Studies

Material and Methods: Twenty-two patients (10 male, 12 female) varying in age from 12 to 38 years served as subjects in the study of the effects of GP breathing on the compliance of the thorax and lungs. All individuals in this group were convalescent poliomyelitis patients with severe impairment of the muscles of respiration, requiring part- to full-time respirator care. The group was subdivided on the following basis: eight patients who were able with GP breathing to attain greater than 40 per cent of the predicted lung capacity; seven patients who were able with GP breathing to attain greater than 20 per cent, but less than 40 per cent of their predicted total lung capacity; and seven patients who attained less than 20 per cent of their predicted total lung capacity with or without GP breathing.

Vital capacity measurements varied from 30 to 1,151 cc. Pulmonary function and GP breathing were measured

Table 1: Data Pertaining to Ventilation Studies and Pressure-Ventilation Relationships in the Twenty-Two Patients in the Compliance Study.

					Vital Capacity		Maximum GP Breath		Tidal Volumes Attained in % of TLC* with Varying Intratank Pressures				
Group	Patient	Sex	Age	Date of Onset	Ml.	% of Predicted Normal	Ml.	As % of TLC*	−5 Cm. H_2O	−10 Cm. H_2O	−15 Cm. H_2O	−20 Cm. H_2O	−25 Cm. H_2O
I	L. C.	M	28	Dec. 54	1151	26	3030	54	10.8	16.2	20.0	23.3	29.2
	L. B.	M	35	Aug. 54	484	11	2969	52		10.6	13.8	16.9	22.7
	G. H.	F	28	Oct. 54	833	26	2030	51		12.2	15.2	22.8	28.2
	E. M.	M	35	Aug. 53	485	12	2666	51	4.0	6.9	11.0	13.8	19.0
	S. M.	F	21	Oct. 54	636	19	2060	50	10.3	14.8	20.0	23.7	28.8
	N. S.	M	20	Oct. 54	242	5	3090	47	5.2	10.3	16.0	21.1	27.3
	P. D.	M	34	Aug. 52	909	22	2363	45		8.1	10.5	13.4	16.9
	W. B.	F	20	Aug. 54	333	10	1818	44		6.6	12.4	17.5	21.9
								Average	7.6	10.8	14.8	19.1	24.3
II	E. S.	F	34	Aug. 50	152	5	1307	36		6.7	8.4	11.4	13.9
	H. S.	M	21	Sept. 52	454	10	1939	35		6.6	10.9	13.7	15.8
	D. K.	M	29	Nov. 54	833	20	1757	34		8.2	12.3	15.2	17.0
	C. S.	M	37	Aug. 54	30	1	1757	33			9.13	12.60	13.2
	M. S.	F	14	Sept. 51	750	23	1200	29	9.7	12.6	14.90	17.10	20.1
	M. M.	F	20	Feb. 54	575	18	1181	29	6.3	10.4	14.00	18.6	
	N. B.	F	29	Oct. 54	878	28	878	23	4.6	7.7	9.8	16.1	21.4
								Average	5.2	7.5	11.4	14.9	16.9
III	R. N.	M	12	Nov. 54	333	8	1000	19	3.4	4.6	7.3	9.0	10.3
	L. M.	F	38	July 52	100	3	500	12	5.9	10.1	13.4	17.8	20.1
	R. V.	F	23	Oct. 52	450	14	...	12	6.4	9.0	15.1	19.1	21.9
	S. C.	F	15	Aug. 54	30	1	...	10	4.4	6.5	9.2	11.4	
	P. O.	F	16	Aug. 49	455	14	...	10	6.0	7.5	8.2	9.0	12.0
	R. C.	F	30	Sept. 52	333	11	...	9		8.1	10.7	15.7	18.1
	B. W.	M	33	Oct. 52	463	10	...	8		6.0	7.6	10.4	13.1
								Average	5.2	7.4	10.2	13.2	15.9

*TLC = Predicted normal total lung capacity.

on a continuously recording spirometer equipped with a standard rubber mouthpiece and nose clip. Serial pressure-ventilation studies were obtained with the patient in a tank respirator operating at a predetermined rate and at various negative pressures, according to the procedure of Waters and co-workers.[4] Values for predicted normal vital capacity and predicted total lung capacity were derived from the regression formulas of Baldwin and others.[5]

Results: Table 1 presents the data pertaining to ventilation studies and pressure ventilation relationships accumulated on the three groups described. Figure 1 shows the average pressure-ventilation curves of the three groups of patients when subdivided on the basis of ability to expand the thorax and lungs with GP breathing. The curve with the most vertical slope represents the group able to expand the lungs over 40 per cent of the predicted total lung capacity. A more vertical slope is indicative of a more elastic or compliant chest. Figure 2 shows the results of comparison of only those patients with greatly reduced vital capacities (less than 20 per cent of the predicted norm). The most vertical slope is again found in the group able to expand the lungs and thorax over 40 per cent of the predicted total lung capacity with GP breathing.

Discussion

Some of our findings have substantiated those recently reported by Dail, Affeldt, and Collier.[6] Many of our patients depend on GP breathing for the major portion of their unassisted breathing time, and some depend entirely on this technic when they are unassisted by mechanical aids. Frequently patients will use GP breathing when they wish to speak loudly, cough effectively, or increase the scope or intensity of their physical or social activities. All patients who can accumulate air with GP breathing spend some time daily in act-

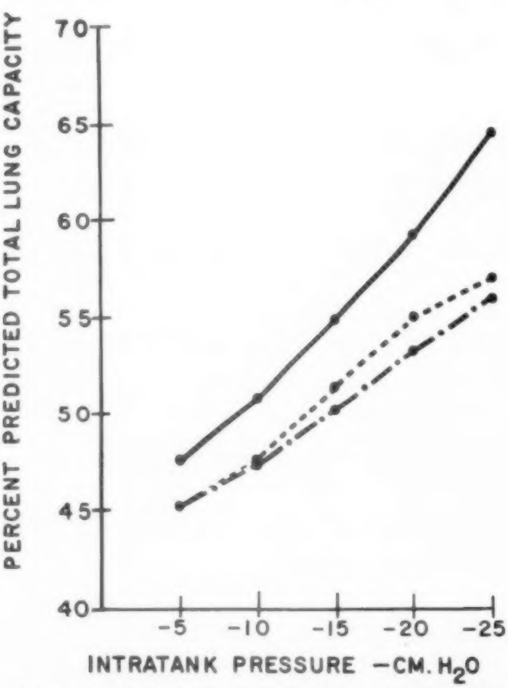

Fig. 1 — Comparison of the results of pressure ventilation studies in 22 patients divided into three groups according to their abilities to expand the lungs and thorax with GP breathing: — 8 patients with maximal GP breath greater than 40 per cent total lung capacity, --- 7 patients with greater than 20 per cent and less than 40 percent total lung capacity, -·- 7 patients with less than 20 per cent total lung capacity.

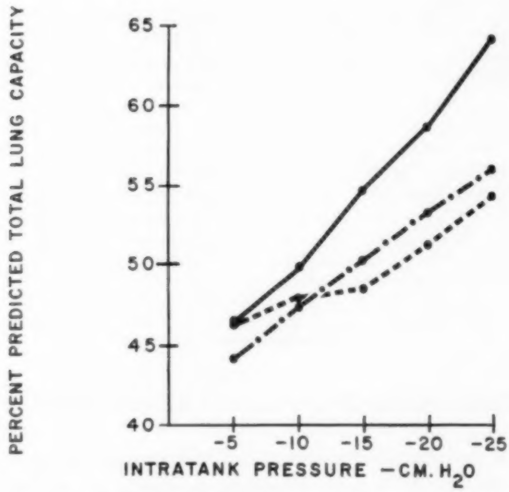

Fig. 2 — Comparison of the results of pressure ventilation studies in 16 patients with vital capacities of less than 20 per cent of predicted normal capacity, divided into three groups according to their ability to expand the lungs and thorax with GP breathing: — 5 patients with maximal GP breath greater than 40 per cent total lung capacity, --- 4 patients with greater than 20 per cent and less than 40 per cent total lung capacity, -•- 7 patients with less than 20 per cent total lung capacity.

ively stretching the chest to minimize the loss of elasticity in the lungs and thorax.

Ferris and his associates[2] have pointed out the need for physical medicine procedures designed to stretch and maintain the mobility of the thoracic structures. The results from the present study would seem to indicate that a more compliant chest could be achieved by periodically expanding the thorax and lungs with deep GP breaths. With a more elastic chest, the work of breathing would be decreased, more time could be spent free of respirator aid, and lower negative pressures would be required to achieve adequate ventilation. The use of this technic of breathing by patients with greatly reduced vital capacities might mean freedom from the tank respirator and an increase in the ability to use other less confining and less efficient respiratory aids. GP breathing has the additional advantage of being a technic that can be performed by the patient without nursing or medical assistance. This is in contrast to mechanical devices attempting to expand the chest maximally. The sense of security and freedom from mechanical aids is certainly a most desirable attribute of GP breathing.

Summary

GP breathing has been taught to 43 patients at the University of Michigan Poliomyelitis Respirator Center according to the technic described by Dail and his associates.[8] Thirty-eight patients have become proficient in this technic; their ability to learn GP breathing did not appear to be limited by vital capacity, sex, or duration of the disease. Failure to learn GP breathing seemed to be related to inadequate instruction, lack of motivation, or paralysis of the pharynx or larynx. It would appear that poliomyelitis patients with respiratory muscle involvement are able to minimize the loss of elasticity of the lungs and thorax by periodically expanding thoracic structures using deep glossopharyngeal breaths. This method of stretching of the thorax and lungs seems to be more acceptable to the patient, and apparently is more effective than various mechanical devices.

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THE SECOND WORLD REHABILITATION FILM AWARDS

Recognition of the importance of the medium of film presentation in advancing all aspects of the work for the world's physically handicapped will be stressed again during the Seventh World Congress of the International Society for the Welfare of Cripples, to be held in London, July 22-26, 1957, when the World Rehabilitation Film Awards will be announced for the second time. The producers of the film taking first place will receive a Plaque of Honor and Certificates of Merit will be awarded to other outstanding films. In announcing these awards, Dr. Howard A. Rusk, President of the International Society, indicated that the selection of winning films will be made by an international panel of rehabilitation experts on the basis of technical accuracy, clarity of presentation and world-wide adaptability. To be eligible, a film must have been released after August 1, 1954, in 16 mm. form and be available for showing in London not later than May 15, 1957. Nomination forms may be obtained from the International Film Library, International Society for the Welfare of Cripples, 701 First Avenue, New York 17.

AWARDS IN GERONTOLOGY

The Ciba Foundation for the Promotion of International Cooperation in Medical and Chemical Research (41 Portland Pl., London, W.1) announces that not less than five awards, of an average value of $843 will be made in 1957 for experimental research into basic problems of aging. The announcement of awards will be made in July, 1957, and preference will be given to younger workers. The work submitted should not have been published before May 31, 1956, though it may have been under consideration for publication at that date. Papers (not more than 7,000 words) must be received not later than January 31, 1957, by G. E. W. Wolstenholme, Director and Secretary to the Executive Council of the foundation.

Skin Temperature Studies in Rocking Bed Treatment with Peripheral Vascular Disease

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This preliminary study was conducted to determine the effectiveness of the rocking bed in peripheral vascular disease. Consideration was also directed to the mechanism of rocking in the circulation of normal extremities. A review of the literature revealed that the rocking bed had many features that might play a role in the mechanism of peripheral blood flow. In experiments to be presented, attention was directed to those factors that were germane to the problem.

Posture and Blood Flow

Sanders[1] recognized the benefits produced by postural changes. He felt that the effects of gravity facilitated and improved the blood flow on tissue fluid exchange. The rocking bed, which electrically controlled changes in the patient's posture without any exertion on the part of the patient, could passively benefit persons with peripheral vascular disease.

The reaction of the human body to total immobilization has been fully studied in recent years. That the rocking bed might mitigate the deteriorating effects of enforced rest presented a comforting concept. Whedon, Deitrick and Shore[2] thought that the rocking bed favorably modified or prevented in a large measure many of the metabolic and physiological consequences of immobilization. In quiet standing, it had been calculated that 500 cc. of extra blood gravitated in the legs and that another 400 cc. might be lost from circulation as the result of the increased hydrostatic pressure on the veins and filtration through the capillary walls into tissue spaces. The present study, therefore, included patients with cervical and lumbar paraplegia and severe poliomyelitis residuals of the lower extremities. These extremities have an impoverished blood flow as a result of paretic muscle mass and are subject to tissue breakdown. The stasis of blood in the lower extremities is an accepted situational involvement in these patients. When the patients stand, their extremities develop a dusky cyanosis in a short time.[3]

In disuse atrophy, osteoporosis, and hypercalcinurea with the formation of urinary calculi in paraplegics, it was thought that the oscillating bed could be effectively used.[3] The rationale was based on three possible mechanisms: weight bearing through the long bones of the lower extremities, pulls and stresses on muscular attachments to the bone by contractions of the muscles, and circulatory changes in the lower extremities. Results in preventing these deleterious aftermaths were disappointing. Mechanical agitation alone could not recreate a disturbed biophysical fluid vascular system.

Skin Temperature and Blood Flow

Another question is the correlation between skin temperature and blood flow in the peripheral field. The temperature of the skin, like that of any part, depends on the amount of blood flowing through it, which in turn depends on the caliber of the arterioles.[3] The capillaries regulate the amount of blood present in any part at a given time. In response to cold stimuli the cutaneous arterioles are constricted to diminish the heat loss and the blood is driven into the circuits of the body.[4]

In estimating the quantitative rise in skin temperature in a given digit, it is not the absolute rise that is significant, but how nearly the rise approaches the normal vasodilatation level.[5] The absolute rise depends in part upon the initial coolness of the extremity, while the degree to which the skin temperature approaches a normal vasodilatation level

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is a measure of the degree or completeness of arteriolar dilatation. The normal vasodilatation level has been placed at 33.5 C. This means release of sympathetic control. It is important to note that patients with fairly severe arteriolar sclerosis will have temperatures that approach normal vasodilatation levels after a wait of 2 to 3 hours; hence, the time limit of 1 hour should be set for testing.[6]

In commenting on the effectiveness of the oscillating bed, Horton, Krusen and Sheard[6] noted no appreciable rise in the temperature in vascular involvement of the extremities even after 4 hours of rocking. When the temperature in the region of the feet was elevated by means of a local heater from 25 to 30 C., however, there was a 9 degree rise. Barker and Roth[7] concluded that the technic should include an environment temperature of 86 F. (30 C.) for the vasodilatating effect. They noted only minor changes in skin temperature after considerable rocking; however, since their patients had either had breakfast or lunch just prior to rocking metabolic errors were introduced.

Possibility of Massage

The possibility that the mechanical action of the rocking bed might be one of passive exercise and massage has been considered. During muscular exercise there is an initial tendency for the skin temperature of the trunks and legs to rise.[7] This rise is soon halted and quickly followed by a fall, which is due to cooling as a result of evaporation and conduction of heat from the deeper structures to the more superficial structures of the skin and the spacing of the collateral circulatory systems. The magnitude of change in blood flow is due to the fact that at lower rates of flow much more heat is removed from each milliliter of blood flowing through the skin.

Rhythmic changes in the color of the skin indicate alternate filling and emptying of the capillary bed. Any relief of pain with rocking comes with induction of sleep which is attended by a definite but incomplete vasodilatation as evidenced by the rise in skin temperature of the digits.[7] Effective treatment with the Sanders bed was studied in six cases. Increase in temperature of the skin as the result of treatment varied from 0.1 to 3.8 C. This increase may have been due to sleep, which is known to cause peripheral vasodilatation.

The rise in the temperature of the peripheral skin is not always of prognostic significance. In early occlusive diseases of the lower extremities there may not be an appreciable rise in skin temperature during treatment, even with clinical improvement. Diagnostically a skin temperature rise may only be of value in advanced occlusive diseases. Pathological changes in the aorta or iliac-femoral system may occur and be far advanced before there is any appreciable change in the peripheral temperature of the toes. In fact, temperatures may well rise within normal levels and only in advanced occlusion of the lower popliteal or tibial region do the peripheral temperatures show lower levels.[8] This would point to the peripheral stage as the major factor in temperature control.

By using central heating up to 40 C. the skin temperature elevation might be of diagnostic value in peripheral arteriosclerosis but does not always coincide with the rise in rectal temperature.

Rocking and Vital Capacity

The rocking bed is also used as an auxiliary treatment in poliomyelitis. The diaphragm is moved up and down in a piston-bellows action, increasing and decreasing the negative pressure within the thorax.[9] It is possible that the intra-abdominal changes in pressure and the sucking action on the large veins play a role in blood flow in the lower extremities.

Clinical investigators[9] have proposed that a direct relationship exists between tidal volume and the magnitude of arc of rocking and put this at about 40 degrees maximum, which could be handled comfortably by patients with poliomyelitis.

Rocking and Blood Flow

In discussing the potentials of the rocking bed as a mechanical factor in

helping circulation, Eve[10] who developed a recognized method of life saving in drowning, felt that rocking promoted venous return and mechanically aided the circulation of the blood. In the head-down phase, the venous blood drains out of the legs into the abdomen and into the heart, and the arterial blood flow is facilitated. During the head-up phase the venous blood drains out of the head and the lower part of the body is fed with arterial blood through venous outflow. The release of sympathetic tone may be responsible for the increase in peripheral blood flow, but the pumping action on the venous system and lymphatics must be considered in this test. In sympathectomized, dependent limbs, the reflexes of the vasoconstriction mechanism that is responsible for blood flow control are absent.[11] In heating of a sympathectomized limb, the opposite, normally innervated limb of the upper extremities failed to mirror an increase in blood flow. Whether this represents a failure of the vasospasm mechanism or vasodilator mechanism is not fully understood. Certainly the nicety of control has been profoundly upset by sympathectomy.

The importance of the Landis-Gibbon[12] test has long been accepted in the diagnostic testing of peripheral vascular diseases; however, beside postural changes of the lower extremities, active exercises of the feet and toes help in increasing blood flow.

Method of Study

In the present study an attempt was made to control many factors that might otherwise introduce physiological errors. The room in which the tests were conducted was air conditioned and kept at a temperature of 72 to 74 F. Baffles in the room prevented possible convection errors. The importance of conducting experiments on peripheral blood flow in stabilized temperatures is well recognized.[13] Green and his co-workers showed that at a low level of skin temperature, a 1 degree rise represents a relatively small increase in blood flow; at medium temperatures, a 1 degree rise means a considerable increase in blood flow, and at high temperatures, a 1 degree rise represents a very large increase in flow. Between the first and fifth toe there was relatively small difference in gradient in surface temperatures, whereas going proximally up the leg, a gradual but definite increase in temperature was noted. There must be a greater collateral bed in the arteriovenous system in the foot than in the higher extremities, thus providing a greater exchange of heat and temperature differentiation.

Relative Humidity and Rocking

The relative humidity was considered to be a factor in peripheral temperature changes. The room in which this study was conducted was kept at 50 per cent of relative humidity or less. To detect whether rapid skin evaporation consequent to the fanning movement of the rocking bed introduced a quantitative error, a wet and a dry bulb thermometer were affixed to the end of the rocking bed in the greatest arc of swing. If evaporation played a factor in lowering or raising skin temperature this would be mirrored in the changes in the wet and dry bulb readings. There was no change after many hours of rocking in either the wet or dry bulb.

The rocking bed was geared down by means of a reduction device to 12 full cycles per minute. The motor itself was covered with an insulating cloth in order to avoid a heat error arising from convection currents.

The patients in this study included normals for determination of base line, known cases of occlusive arteriosclerotic peripheral disease, amputees in this same category, patients who had had poliomyelitis involving the lower extremities, cervical and lumbar paraplegics, and patients with sympathectomized extremities.

These tests were conducted at least 4 hours after the intake of food in order to avoid the specific dynamic action of protein metabolism.[14] Subjects were kept at rest for at least one-half hour prior to rocking for basal temperature and were moved passively onto the bed in order to avoid the factor of muscular metabolic influences.

ROCKING BED AND SKIN TEMPERATURE STUDIES

Skin Temperature	Great Toe		2nd Toe		Ant. Foot		Mid-Ankle		Lower Leg		Upper Leg	
	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.	Rt.	Lt.
1. E. G.—Post-polio, severe, lower ext.												
½ hr. after cooling	29.3	27.6	29.4	27.5	30.2	29.0	30.2	30.2	30.3	29.5	30.5	29.7
½ hr. after rocking	25.6	25.6	26.4	25.7	28.5	28.7	29.2	29.5	29.6	29.9	29.8	30.2
1 hr. after rocking	24.8	24.7	24.7	24.9	27.7	27.6	28.2	29.4	29.4	29.6	29.6	29.9
2. J. F.—Peripheral arteriosclerosis												
½ hr. after cooling	—	32.9	—	33.4	—	33.5	—	32.7	—	33.5	—	33.5
½ hr. after rocking	—	30.4	—	30.5	—	31.7	—	30.3	—	31.0	—	31.2
1 hr. after rocking	—	32.5	—	33.0	—	32.7	—	31.6	—	32.3	—	32.5
3. R. T.—Normal												
½ hr. after cooling	26.2	25.5	25.3	25.8	28.8	29.3	29.9	29.4	31.3	30.2	33.1	32.6
½ hr. after rocking	23.7	24.9	25.2	25.6	27.2	27.7	29.0	28.6	30.6	30.0	32.0	32.3
1 hr. after rocking	23.8	24.1	24.7	24.5	26.6	27.4	27.9	28.0	30.5	30.1	32.5	32.5
4. V. H.—Polio, lower, bilateral, severe												
½ hr. after cooling	27.2	25.5	27.2	25.4	28.0	27.9	28.3	27.7	29.0	28.3	29.9	29.8
½ hr. after rocking	24.9	24.6	25.3	25.0	27.2	27.3	27.1	27.0	28.7	28.2	30.5	29.6
1 hr. after rocking	25.0	25.2	25.0	25.6	26.7	27.6	26.7	26.9	27.5	27.7	29.5	29.8
5. B. S.—Normal												
½ hr. after cooling	26.8	27.5	26.2	27.6	28.4	30.6	30.6	30.5	30.2	30.2	30.2	30.3
½ hr. after rocking	24.7	26.0	24.3	25.7	27.5	29.0	.29.2	29.6	28.3	29.0	28.9	29.9
1 hr. after rocking	24.5	26.2	24.0	26.4	27.1	28.5	28.6	29.6	28.6	28.7	28.7	29.7
6. C. F.—Paraplegia, C-6												
½ hr. after cooling	33.2	31.9	33.1	31.5	32.7	31.7	32.5	31.7	31.6	31.0	32.0	31.4
½ hr. after rocking	27.8	29.2	27.9	29.4	30.2	30.7	30.6	30.4	30.0	30.2	30.4	30.5
1 hr. after rocking	28.7	28.9	28.2	27.9	29.4	30.1	30.5	30.5	30.1	30.2	30.6	30.7
7. M. D.—Paraplegia, D-6 and D-7												
½ hr. after cooling	30.4	28.5	30.7	29.5	32.0	31.0	32.3	31.7	31.5	30.7	30.5	31.2
½ hr. after rocking	31.0	29.5	30.0	30.0	31.2	31.0	30.6	31.7	30.4	30.3	30.6	32.2
1 hr. after rocking	29.5	29.2	30.2	29.2	30.7	29.9	30.7	30.6	29.6	29.5	30.1	29.7
8. E. D.—Normal												
½ hr. after cooling	28.9	29.6	29.6	29.9	31.7	32.0	32.9	33.0	31.4	32.3	31.9	33.3
½ hr. after rocking	25.6	27.0	25.4	26.7	29.5	30.0	30.7	32.2	30.0	31.1	30.6	32.0
1 hr. after rocking	25.2	26.2	24.9	26.1	28.3	29.1	29.9	30.4	28.7	29.9	30.0	31.2
9. C. H.—Rt A-K, Venous occlusion												
½ hr. after cooling	—	30.7	—	31.0	—	32.0	—	32.5	—	32.5	—	—
½ hr. after rocking	—	30.6	—	30.7	—	30.6	—	30.4	—	30.3	—	—
1 hr. after rocking	—	30.2	—	30.6	—	31.2	—	31.7	—	31.4	—	—
10. F. W.—Arteriosclerosis												
½ hr. after cooling	29.9	30.6	28.6	30.2	31.0	32.6	31.3	31.5	31.4	31.2	32.2	32.4
½ hr. after rocking	27.6	30.6	26.8	30.2	29.7	32.2	28.4	30.9	30.2	31.1	31.9	31.4
1 hr. after rocking	26.7	27.2	25.6	27.3	28.7	30.9	28.4	30.4	29.6	30.7	31.0	32.2
11. W. C.—Polyneuritis, lower												
½ hr. after cooling	32.2	30.9	31.4	31.1	33.7	32.9	34.1	32.7	33.9	32.5	32.9	32.4
½ hr. after rocking	29.9	30.4	29.9	30.4	33.3	32.6	33.2	33.1	32.6	33.3	32.3	33.2
1 hr. after rocking	31.3	31.6	31.9	32.0	32.7	32.9	33.0	33.6	32.8	33.0	32.6	32.6
12. H. M.—Cervical paraplegia, C-5, 6												
½ hr. after cooling	32.2	30.9	31.4	31.1	33.7	32.9	34.1	32.7	33.9	32.5	32.9	32.4
½ hr. after rocking	29.9	30.4	29.9	30.4	33.3	32.6	33.2	33.1	32.6	33.3	32.3	33.2
1 hr. after rocking	31.3	31.6	31.9	32.0	32.7	32.9	33.0	33.6	32.8	33.0	32.6	32.6
13. M. H.—Paraplegia, lower, D-9												
½ hr. after cooling	33.2	28.0	34.6	27.9	33.0	31.0	33.2	31.0	32.6	30.6	32.0	31.0
½ hr. after rocking	30.9	25.6	31.8	25.0	30.3	27.4	32.3	28.2	31.7	28.2	30.9	29.9
1 hr. after rocking	31.4	26.2	32.2	27.7	32.2	27.3	33.1	28.2	32.0	28.0	31.1	29.3

Sites of Skin Temperature

Temperatures were taken by means of a Rauh Thermocouple and checked against a continuous Tycos recorder and rechecked against another Rauh instrument. The contact point of measurement was marked lightly with ink at the ends of the following parts: large toe, second toe, dorsum of the anterior foot, mid ankle, lower leg, and upper leg. The end of the stump of amputees was also measured. Subjects were unclad except for a loose loin cloth, women wore a light cloth over the chest. After the patient had rested for one-half hour, basal temperatures were established and recorded. Subjects were placed on the rocking bed. The motor was run for one-half hour, after which the rocking bed was momentarily stopped. Temperatures were taken at the aforementioned sites and the rocking resumed for another half-hour (a total of one hour), after which temperatures were again taken at the same sites. After 15 to 20 minutes of rocking the patients synchronized their breathing with the action of the rocking machine, so that breathing became shallow and automatic. Whether this was in part responsible for failure of the temperature in the periphery to rise is open to question.

Discussion

It is well known that dilatation of small vessels occurs even when circulation is completely occluded in experiments.[15] Any therapy that aims to improve the capacity of the fine peripheral vessels would be superfluous unless it also appreciably improves the blood supply of the larger vessels.

In the aforementioned experiments, a rather remarkable agreement was noted in spite of the different types of vascular involvement. Initially after one-half hour of rocking there was a slight increase in temperature of the peripheral circulation, but after one hour of rocking, there was a consistent fall, which in each case was lower than the basal reading taken after one-half hour of rest. Apparently sympathectomy played no role in the peripheral blood flow, although the initial temperature in these cases was considerably higher than the others; after one hour of rocking these fell below the resting basal levels.

Summary and Conclusion

Skin temperature is considered an indication of peripheral blood flow; however, the various aspects of the rocking bed have been discussed briefly. The rocking bed fails to cause an elevation of skin temperature after 1 hour under controlled conditions and is not considered an effective treatment in peripheral vascular disease.

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"Principles of Rehabilitation"

The very favorable response to the initial presentations by the University of Pennsylvania of the course "Principles of Rehabilitation" has resulted in future scheduling for the following dates: December 10-14, 1956; February 4-8, April 22-26, and June 17-21, 1957.

The course is open to physicians, registered nurses, occupational therapists, social workers, rehabilitation counselors, and others concerned with rehabilitation of the handicapped. Enrollment for each of the five sessions will be limited.

The course is designed to present the basic concepts of rehabilitation in all its aspects. Principles and methods are presented through lectures, clinical demonstrations and group discussions. The instructional staff includes representatives from the various divisions of the University of Pennsylvania, and guest lecturers.

Provisions for granting a limited number of trainee stipends to eligible persons attending the course has been made by the U. S. Office of Vocational Rehabilitation. Requests for detailed information may be addressed to the Rehabilitation Center, Hospital of the University of Pennsylvania, Philadelphia 4.

Histamine Iontophoresis to Prevent Tissue Necrosis Following Levarterenol Extravasation

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Houston

The use of levarterenol (Levophed) as a life-saving measure in the treatment of severe hypotensive shock sometimes is complicated by the development of extensive tissue necrosis at the site of administration of the drug. Such necrosis results from the extreme vasoconstricting action of levarterenol in the local tissues. A procedure was needed that would reestablish circulation in the ischemic tissues and prevent tissue destruction.

Problem

Within the past 9 years, levarterenol has been demonstrated to be present in the body tissues, has been synthesized, and has become widely used as a powerful vasopressor agent to combat hypotensive shock. It is commonly used to control hypotension in such conditions as myocardial infarction, operative and postoperative shock and severe traumatic conditions.

Paradoxically, the life-saving action of the drug sometimes produces complications that greatly increase the morbidity of the patient's illness. When using a levarterenol intravenous infusion, the physician is sometimes confronted with the appearance of a blue-white or purplish discoloration at the site of venipuncture. This may be continuous along the vein, or isolated patches of discoloration may appear along the course of the vein. There may or may not be evidence of leakage of the drug solution at the site of the intravenous infusion. Subsequently, vesicles may form on these patches, and the condition may progress to ulceration and sloughing of necrotic tissue. Sometimes there is only discoloration or a streaky phlebitis, which heals without more serious complication. All degrees of tissue inflammation and damage can occur.

An example of a serious case was that of a 44-year-old man who was admitted to the hospital in hypotensive shock secondary to perforation of a duodenal ulcer. A cut-down was made on a vein in the left ankle and a polyethylene catheter was inserted for administration of intravenous medication. Levarterenol was given in concentrations up to 16 cc. of a 0.2 per cent solution to 1,000 cc. of dextrose solution. On the third day, the infusion ceased running and the leg became swollen. Subsequently, the superficial saphenous system completely sloughed from the ankle where the cut-down was made to the fossa ovalis. Twenty-eight days after the appearance of the levarterenol injury, debridement was done in preparation for skin grafting. At this time the width of the lesion varied from 3 to 8 cm. along the length of the saphenous vein. Necrosis extended down to the muscular fascia.

Microscopic examination of the tissue removed at this time showed extensive foci of necrosis and aggregates of degenerating polymorphonuclear leukocytes. Much of the vein wall showed pyknosis, and in some areas as much as half of the circumference of the vein wall was disrupted and necrotic. Some thrombotic material was present in all of the veins and in the small arteries. In some areas of the specimen there was no infiltration by inflammatory cells, but there was complete loss of differential staining characteristics, a condition considered indicative of ischemic gangrene. Kurland[1] reported a case similar to this. A deep ulcer developed where there had been no obvious leakage. A polyethylene catheter had been inserted in an ankle vein and advanced to the mid-leg. A blue-white discoloration was noted at the tip of the catheter and continuing along the course of the vein; this was followed by a deep, penetrating, secondarily infected ulcer. Complete healing followed debridement and multiple skin grafts.

Hall[2] reported a patient who was

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maintained on levarterenol therapy for 22 days. Besides superficial sloughs of the skin there was one deep ulceration on the posterior thigh, which required over five months to heal. Greenwald[3] reported two cases of tissue necrosis following subcutaneous infiltration of levarterenol. Miller[4] cited a patient who had sloughing of the skin from the dorsum of both hands at the site of venipuncture. Uricchio[5] reported a case of a 48-year-old patient who had severe peripheral arteriosclerosis and who had lost one leg because of circulatory deficiency. This patient developed shock following a colostomy, and a cut-down was made on an ankle vein with insertion of a plastic cannula. Only 100 cc. of levarterenol solution was administered to bring the patient out of shock; yet, within 24 hours, ulcers and blebs developed along the course of the saphenous vein. There had been no leakage of solution at the site of venipuncture. The plastic cannula had been of value in preventing local extravasation but it did not prevent the development of venispasm and tissue necrosis. Twenty-eight days later it was necessary to amputate the extremity.

I have seen 12 patients in whom the levarterenol injury was severe enough to elicit concern over possible occurrence of tissue necrosis and slough. These will be discussed later.

Rationale

In normal physiology, levarterenol is steadily released at the sympathetic nerve endings and causes constriction of the local blood vessels.[6] It has been verified in several ways that levarterenol is the adrenergic neurotransmitter.[7] The vasoconstriction effected includes all vessels: the arteries, arterioles, capillaries, venules, and veins.[8]

Levarterenol is used therapeutically in a relatively concentrated solution as compared to the natural dilution of the substance in the tissues. If the intravenous solution extravasates into the tissues either at the site of venipuncture or at an erosion in the vessel wall, or if there is retrograde flow of the solution into venules and capillaries, extreme constriction of the vessels contacted by the concentrated drug follows. The site becomes pale, cold, and firm to the touch. This may be followed some hours later by discoloration, vesicle formation, and necrosis.

In order to counteract this almost total ischemia and to prevent tissue destruction, it would be desirable to introduce a vasodilating drug into the involved tissues. Levarterenol acts directly on the vessel wall; therefore, there might be some advantage in employing a dilator drug that likewise acts directly on the vessel wall. Histamine effects vasodilatation by such direct action and also by reflex action.[9] Some clinicians feel that, of all vasodilators, histamine produces the greatest reaction and greatest increase in blood flow.[10] Some evidence indicates that the vasodilatation induced by histamine is not temporary, but persists in some degree after the drug has left the tissues.

If a vasodilating drug were to be used on a patient in hypotensive shock, it would be most important to restrict the drug to a limited area and to limit the quantity of drug so that there would be no systemic effects and lowering of blood pressure. Iontophoresis was chosen as the method of introducing the histamine into the ischemic tissue. In this technic, the positively charged histamine ions are transferred into the skin by means of a direct (galvanic) current.

Method

A galvanic generator was used to supply a direct current for ion transfer. A histamine-containing ointment known as Imadyl Unction was used as a convenient source of histamine.

The area was prepared by removing from the site any wet dressings or damp bed clothes, which could conduct electricity. The skin was examined for any broken places, such as the site of venipuncture. Small broken areas were covered with transparent tape for protection against a galvanic burn. Large denuded areas were avoided and treatment was given on their periphery. A small amount of the ointment was gently spread on the discolored area and for 2.5 cm. beyond the border of the dis-

colored area. A soft cloth moistened with tap water was folded to the shape of the area to be treated and placed on the area so that good contact and equal pressure at all points was obtained. The positive electrode of a galvanic generator was placed on this pad. The electrical circuit was completed by placing the negative electrode on some other part of the body. A current of 10 to 30 milliamperes (varied according to the size of the electrode) was applied and continued until an erythema was induced under the positive electrode. The iontophoresis was never continued more than 10 minutes, even though an erythema did not occur. It was felt that frequent observation of the site during treatment was important in order to obtain the best degree of erythema without inducing wheal formation. The treatment was repeated twice a day in severely involved cases and once a day in milder cases.

Results

The patient that stimulated interest in this technic was a 23-year-old male who developed shock secondary to acute pericarditis. Levarterenol was administered in the right antecubital vein in a concentration of 4 cc. per 1,000 cc. of glucose solution. Discovery was made that approximately 25 cc. of the solution had extravasated into the antecubital space and forearm. Four hours later, a histamine iontophoresis was given to the involved area. Before treatment, the area was white and cold; after treatment, the area was pink and warm. Only one treatment was given to this arm, and no evidence of tissue damage ever appeared. On the following day while a levarterenol venoclysis was being given in the other (left) arm, the solution stopped dripping and was discontinued, but there was no suggestion of leakage. Because leakage could not be seen, no histamine iontophoresis was given to this arm. Subsequently a slough 0.5X0.75 cm. occurred at the venipuncture site in this arm. This case aroused interest because the large extravasation with treatment produced no tissue necrosis while the imperceptible leakage (on the same patient) produced a slough.

Cases in which treatment was administered within several hours after levarterenol extravasation or evidence of injury was noted are presented in the accompanying table.

Comment

In the cases reported, the amount of local vasodilatation and improvement obtained from the use of histamine iontophoresis was directly proportional to the degree of hypotensive shock. There was little or no improvement of the histamine-treated levarterenol injury in any patient who expired within a few days after the

Patients Treated by Histamine Iontophoresis After Extravasation of Levarterenol

Patient	Site of Injury	Results
J. W.	Antecubital area, recent (1½ hr.) extravasation, 5 X 8 cm. Skin blanched.	Complete recovery in 2 days (3 treatments).
. . .	Discolored area 6 cm. wide from ankle to knee; 9 hr. following extravasation.	Treated for 2 days. No vesicle formation or necrosis. Discoloration gradually cleared over one month's time.
F. L.	Left ankle. Deep purple discoloration, 4 X 6 cm.	Improved after two daily treatments. Slight bluish discoloration remained. Expired 4 days later (rabies).
R. S.	Antecubital area, recent extravasation (4 hr.). Skin blanched.	One treatment given. No later evidence of tissue damage.
L. M.	Extravasation in left forearm 10 X 12 cm. (1½ hr.).	Completely cleared in 2 days (3 treatments).
. . .	Discolored area right forearm 10 X 23 cm. (6 hr.).	Vesicles formed on 2nd day. Healed in one week (3 treatments).
O. K.	Extravasation in antecubital area (5 hr.).	Two daily treatments, with complete clearing.
. . .	Discolorations along lesser saphenous veins (4½ hr.).	Eschar formed from ankle to knee. No slough. Complete healing under eschar in 2 months (2 treatments).
W. Z.	Patches of discoloration along greater saphenous vein in leg.	Treated for 3 days. Lesions became progressively worse with vesicle formation. Patient expired on 3rd day.
I. K.	Discolored areas, 3 days old, dorsum of hand, 4 X 5 cm. Antecubital area, 4 X 5 cm.	Completely cleared in 2 days.
K. T.	3 cm. blue-black area above ankle cutdown.	Completely cleared within 24 hr.
J. L.	Blue-black areas over lesser saphenous veins, both legs.	One leg improved. The other leg became worse with bleb formation. Expired on 4th day.
F. B.	Darkened area with some superficial maceration. Antecubital area.	Treated daily for 3 days. Little improvement. Expired on 4th day.

injury. On the other hand, the group of patients who eventually survived the hypotensive shock showed improvement of the local injury within 24 hours after treatment. Undoubtedly the following factors affect the degree of tissue injury: individual susceptibility, presence of peripheral vascular disease such as arteriosclerosis, rate of blood flow (affecting rate of dilution), degree of hypotensive shock, occurrence of retrograde flow, and concentration of the drug.

There had been some concern about the systemic effects of histamine and the adverse effects it might have on the patients' state of shock. This was difficult to evaluate because the patients' blood pressures were usually fluctuating and the levarterenol drips were frequently being readjusted. Nevertheless, blood pressure readings were carefully observed before and after treatment; a definite depression was never noted that could be attributed to systemic absorption of histamine from the site of treatment.

Summary and Conclusions

A method of treatment is presented that has been of assistance in preventing local tissue necrosis that sometimes follows the administration of levarterenol for control of hypotensive shock. Histamine iontophoresis was found to counteract effectively the local vasoconstricting action of the drug and thus aid in preventing local tissue destruction. In this series of cases there were no indications that the local application of histamine had any adverse effect on the hypotensive shock.

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editorial

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AMERICAN ACADEMY OF PHYSICAL MEDICINE AND REHABILITATION

Objectivity in Physical Medicine

Tradition can be a more effective brake against the wheels of progress than actual opposition. In the field of physical medicine today the notions and cliches of tradition are tending to retard teaching in medical schools, to slow research in bio-physics and to discourage the application of known principles of physical medicine and rehabilitation in daily practice. Our British counterparts have gone through considerable soul-searching recently to discover whether certain usual procedures in physical therapy are really effective as therapy or merely wasteful of moneys from the public purse. In the process a considerable element of empiricism in physical medicine has been revealed, but also a disturbing failure to point up the positive findings of the past two decades in this discipline.

A glance at the list of scientific papers presented at the September meeting of the American Congress of Physical Medicine and Rehabilitation should impress even a casual reader with the fact that an immense amount of very objective work has gone into the preparation of these papers. The breadth of scope of the program indicates how physical medicine now pervades all other areas of medical thought. The tools of diagnosis, methods of measurement and evaluation, and technics of physical treatment are being applied with exactness which has characterized only the meticulous research of former years. Surgeon, internist, general practitioner and student can find much of interest and challenge throughout the program, and many practical technics which are as useful and objective as any methods which are available in the medical arts today. The point is that physical medicine and rehabilitation has gone far ahead of the traditional concepts to which many physicians hold. All too many otherwise excellent teachers and physicians have remained as ignorant of the field as though they still live in the era of "calomel followed by salts." So long as this anachronistic attitude toward physical measures in medicine persists, physical medicine will tend to lag, in spite of the most objective attitude on the part of doctors and therapists who are identified with it.

The objective approach to medicine requires analytical diagnosis, not merely the choosing of a name for the clinical entity which faces us. This necessitates a search for the nature of the physiological disturbance and the gross and histological changes which accompany or underlie the departure from normal. The next element in this search is an evaluation of the degree or extent of the process. Finally, there must be a plan for treatment, which should include all measures which might influence the condition, such as dietary management, drugs, possible surgical procedures, and all physical measures which are indicated, such as cold, heat in some effective form, mechanical technics of rest, traction, passive or active movement and specific dosage of any combination of these.

By such a process of analysis the objective thinker visualizes the actual changes going on in the tissues, both gross and microscopic, and chooses physical and medical measures which are known to produce tissue responses which tend to restore homeostasis; then he

prescribes such dosage, in terms of exact units of energy and time, as to secure desired changes in the state of the tissues. The fact that there is a great body of objective evidence to support this sort of clinical application of physical energies and measures seems to have escaped a great many clinicians. A result of this ignorance is perpetuation of the old tradition that physical medicine must somehow be empirical and hence not quite scientific. The reverse is coming to be true; that is, it is empirical to omit the physical elements in the management of a very wide variety of surgical, medical and even psychiatric conditions. It is the physician's duty to acquire some knowledge of physical measures which are available. It would also seem incumbent upon all who represent the healing art to make every effort to improve facilities for physical medicine and rehabilitation, to apply the principles which have stood the test of objective investigation, to avoid procedures which are not of proved worth, and to encourage the analytical approach to each medical entity. Such objectivity in physical medicine can and will lay the ghost of empiricism.

Arthur C. Jones, M.D.
Portland, Ore.

Awards of Merit for the Year 1956

The Committee on Gold Key Award presented through its Chairman, Dr. Donald L. Rose, the distinguished service key to:

MILAND E. KNAPP, M.D., in recognition of his services as practitioner, consultant, university professor, director and authority on the treatment of poliomyelitis, whereby, with the advantage of a background in surgery, he has interpreted to members of the general medical profession the aims and ideals of his colleagues in the field of physical medicine and rehabilitation; who, by his many accomplishments has notably advanced the Science and the Art of Physical Medicine and Rehabilitation.

Doctor Knapp is a native of Minnesota. He received the degree of master of science in physiology in 1928 and the degree of doctor of medicine in 1929, both from the University of Minnesota, where he also served a teaching fellowship in surgery from 1930 to 1933. He has been in private practice in Minneapolis since 1933; in 1947, Dr. Knapp became a diplomate of the American Board of Physical Medicine and Rehabilitation. He is clinical professor of physical medicine and rehabilitation at the University of Minnesota; director of physical medicine and rehabilitation at the Elizabeth Kenny Institute in Minneapolis, and a member of the board of directors of the Kenny Foundation, serving as director of the training course. He is consultant in physical medicine and rehabilitation for the Veterans Administration. He was president of the American Congress of Physical Medicine and Rehabilitation in 1944. He is a charter member of the American Academy (formerly Society) of Physical Medicine and Rehabilitation and served as president of the organization in 1951.

Dr. Miland Knapp is presented with the Gold Key of the American Congress of Physical Medicine and Rehabilitation by Dr. Donald L. Rose, Chairman of the Committee on Gold Key Award.

Awards to Scientific Exhibitors

The committee on Awards for Scientific Exhibits presented through its Chairman, Dr. Clarence W. Dail, the following:

Gold Medal to Donald L. Rose, M.D.; Stanley F. Radzyminski, M.D., and Ralph R. Beatty, M.D., for the exhibit "The Effectiveness of Brief Maximal Exercise on the Strength of the Quadriceps Femoris."

Dr. Donald L. Rose accepts congratulations from Dr. Clarence W. Dail, Chairman of Committee on Awards for Scientific Exhibits. The Gold Medal was presented to Dr. Rose and his associates, Dr. Radzyminski and Dr. Beatty.

Silver Medal to Walter J. Treanor, M.D.; Lt. Col. Raoul C. Psaki, MC; Lt. Col. Ernst Dehne, MC, and Capt. William M. Gilmore, MC, for the exhibit "The Management of Spastic Paresis."

The Silver Medal, awarded to Dr. Treanor, Lt. Col. Raoul C. Psaki, Lt. Col. Dehne, and Captain Gilmore, is being accepted by Col. Psaki's father, Dr. C. Psaki of Pennsylvania, on behalf of the exhibit sponsors.

Bronze Medal to Arthur A. Rodriquez, M.D.; Y. T. Oester, M.D.; John Fudema, and J. A. Fizzell, for the exhibit "Electromyography in Clinical Practice."

Dr. Arthur A. Rodriquez is shown accepting the Bronze Medal for the scientific exhibit sponsored by Dr. Oester, Mr. Fudema, Mr. Fizell, and himself.

Honorable Mention to Leon Lewis, M.D.; Gerald G. Hirschberg, M.D., and J. Patrick Adamson, M.D., for the exhibit "Rehabilitation of the Poliomyelitis Patient with Respiratory Paralysis."

Russell L. May, M.D.

Prize Lecture Award

The Committee on Prize Lecture, presented through its Chairman, Dr. Frederic T. Jung, the award to:

RUSSELL L. MAY, M.D., for his paper "A Method for Recording the Progress of Scoliosis and Other Trunk Deformities with a Review of Previously Suggested Methods."

Dr. May's pre-medical studies were completed in 1952 at Asbury College in Wilmore, Kentucky. He was graduated from Vanderbilt University Medical School in June, 1956. While at Vanderbilt, largely through the influence of Dr. J. William Hillman, his interest in trunk deformities, especially scoliosis, was developed. Dr. May is now serving a rotating internship at Indiana University Medical Center.

book reviews

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The reviews here published have been prepared by competent authorities and do not necessarily represent the opinions of the American Congress of Physical Medicine and Rehabilitation and/or the American Academy of Physical Medicine and Rehabilitation.

CLINICAL ELECTROCARDIOGRAPHY. I. Arrhythmias. With an Atlas of Electrocardiograms. By *Louis N. Katz,* M.D., and *Alfred Pick,* M.D. Cloth. Price, $17.50. Pp. 737, with 415 illustrations. Lea & Febiger, Washington Sq., Philadelphia 6, 1956.

This book is the successor to Dr. Katz's two editions on Electrocardiography. The authors felt that it would be better to divide this work into two volumes. This first volume is entitled "The Arrhythmias." The second volume will be "Electrocardiographic Contours."

This work is divided into two sections and two appendices. Section I contains the general considerations and the theoretical background of arrhythmias. Section II is a systematic description of arrhythmias. Appendix I is the approach to an unknown arrhythmia and Appendix II a classified coding system of normal and abnormal rhythms.

Each descriptive section is followed by many excellent reproductions of electrocardiographic tracings with elaborate explanations of the abnormalities found. Each chapter is completed with its own bibliography.

This book is not difficult to read but requires the utmost in concentration to follow the context, to understand the nature and cause of the particular arrhythmia. It assumes that the reader is familiar with the technic of taking electrocardiograms. It does not go into the methods or theory of procuring the tracings be it by the standard, chest or unipolar leads. This is of course no problem to the well trained internist of today.

The text type is large and makes for comfortable and easy reading. However, the gloss of the pages reflects artificial light to a disturbing degree. The weight of the book is deceiving due to the heavy paper used.

The book should have considerable value to all those who daily or occasionally read electrocardiograms but whose backgrounds are not profound enough to understand all the complexities of the many variables which can produce a given arrhythmia.

PHYSIOLOGY AND ANATOMY. With Practical Applications. Seventh edition. By *Esther M. Greisheimer,* Ph.D., M.D. Cloth. Price, $5.00. Pp. 868, with illustrations. J. B. Lippincott Company, E. Washington Sq., Philadelphia 5, 1955.

Instruction of nursing students in physiology and anatomy is of such importance that a new and improved edition of a widely used and appreciated textbook is welcome. This book is of real value, and is recommended for consideration when choosing a text for student nurses.

The chapters begin with a short introduction which serves to orient the reader before the details are encountered. Each ends with an outlined summary, to facilitate review after study. The excellent descriptions of anatomy are followed by clear and concise accounts of the physiological processes for each system. All the chapters have been re-written. The nervous system has been condensed into two chapters, and the chapter on endocrines is given a complete re-casting.

This book is clearly written, and the text is supplemented by many new illustrations. Others have been re-evaluated, resulting in noteworthy clarity. The book is well produced and stands as a credit to the author and publisher. It is recommended to all who desire a textbook for teaching nurses.

ESSENTIALS OF CHEMISTRY. Sixth edition. By *Gretchen O. Luros,* M.A. Leatherette. Price, $4.75. Pp. 544, with illustrations. J. B. Lippincott Company, E. Washington Sq., Philadelphia 5, 1955.

A new edition of a widely used textbook is presented. Much of the previous material has been supplemented and revised, incorporating additional emphasis on organic and biological chemistry. In some cases, completely new topics have been presented in keeping abreast of the newer concepts and developments in chemistry which need to be introduced into the nursing curriculum.

In keeping pace with more recent progress, the author has incorporated many new applications of chemistry, namely, a discussion of some of the fundamental concepts on radioactive isotopes and their correlation with the practical applications in medical science. The section on organic chemistry has been enlarged and divided into two sections. The section on biochemistry has also been enlarged and new topics are introduced which include a brief discussion on the ever-increasing list of anti-

biotics and the wonder hormones, namely, adrenocorticotropin and cortisone.

The author's objective, to present a textbook for nurses with sufficient up-to-date material for a well-rounded sixty to ninety hour course with emphasis on organic and biological chemistry, has been achieved.

DIZZINESS: AN EVALUATION AND CLASSIFICATION. By *David Downs De Weese*, M.D. Cloth. Price, $2.75. Pp. 80, with illustrations. Charles C Thomas, Publisher, 301-327 E. Lawrence Ave., Springfield, Illinois, 1954.

The author gives a very good description of the multiple conditions that can cause dizziness. He made an attempt to classify the different forms of dizziness with all the methods of examination available. He analyzes the physiology of the statokinetic system. There is a very good study of nystagmus as well. Dizziness has to be differentiated from vertigo or other conditions. All the different systems, eyes, proprioceptive, and central nervous system were reviewed and the mechanisms responsible for dizziness were analyzed. The author describes the different conditions, infection, trauma, tumor, migraine, epilepsy, including psychoneurosis, that might be responsible for dizziness. He reported a series of cases which are very instructive. As a whole, the author has achieved his aim, that is to say, he gave a good analysis of the physiopathology of the condition and in addition he showed good clinical studies. This monograph should interest any one in medicine, as dizziness is a complaint so frequent in different pathological conditions.

YOUR BLOOD PRESSURE AND HOW TO LIVE WITH IT. By *William A. Brams*, M.D. Cloth. Price, $2.95. Pp. 160. J. B. Lippincott Company, E. Washington Sq., Philadelphia, 1956.

It is a timely book inasmuch as a great deal has been written on the subject in the press and magazines. The author is straight forward in his presentation and remarks. It is written in every day language which helps to bring the message to the general public. Case presentations help to visualize the author's presentations. The chapters on pathology, diet and admonition on how to live a useful life with blood pressure abnormalities further add to the value of the book.

Appendix III could be enlarged in order to cover more extensively the intrinsic value and procedures in medical, social, spiritual and economic rehabilitation.

Dr. Brams has done a good public relationship service both to the public and the medical profession through his excellent book. The book should be a part of everyone's daily living.

ESSAYS IN BIOCHEMISTRY. Edited by *Samuel Graff*. Cloth. Price, $6.50. Pp. 345. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, 1956.

Essays in Biochemistry is a "Festschrift" collection of twenty-five articles covering a wide range of subject matter. All the articles were written either by former students or associates of Professor H. T. Clarke on the occasion of his retirement from the Department of Biochemistry at the College of Physicians and Surgeons, Columbia University.

The essays are informally written. Some tend toward the review type article while others state current problems or even speculate on future research trends. The last type certainly presents easy and stimulating reading. Their subject matter ranges from determination of the chemical structure of proteins to the nature of cancer and should be of interest to all persons working in the biological field.

The reviewer wishes to point out that the book is not meant to be a reference work; it is, as the title indicates, a group of isolated discussions with no thought of giving complete surveys of each or any field.

SCIENCE THE SUPER SLEUTH. By *Lynn Poole*. Cloth. Price, $2.75. Pp. 182, with illustrations. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, 1954.

Science The Super Sleuth is the Sherlock Holmes of scientific investigation outlining the various methods of crime detection. In combating criminals with its exposures, the book presents the subject matter in a very vivid form strengthening its message with good pen and ink illustrations. Short chapters usher the readers through laboratories, crime scenes, forgeries, safecracking and the realm of suicides. It is really revealing that an infinitesimal clue can build up a strong and convincing evidence which holds invincible in the courts.

The reader is presented with a true detective story through case reports and the stories become living realities as a result of the methodical solution of the crimes. Mr. Poole's book is only useful for coroners, lawyers and doctors but it may be a deterring factor in crime prevention because it clearly demonstrates that crime does not pay in the face of the present methods of detection and laboratory analysis.

PHYSIOTHERAPY IN PARAPLEGIA. By *Elvira P. G. Hobson*, F.C.S.P. Cloth. Price, $1.75. Pp. 110, with 30 illustrations. J. & A. Churchill Ltd., 104 Gloucester Pl., London W. 1, 1956.

The extensive personal experience of the author well qualifies her for writing this com-

prehensive and practical book concerning the principles and methods of treatment of the paraplegia patient.

The book is divided into six chapters, the first concerned with an introductory survey which traces the history of the paraplegia through World Wars I and II in England, and the last with the rehabilitation of the paraplegia in the United States of America and other countries. The two chapters that deal specifically with the principles and methods of treatment, and complications to which the paraplegia is prone are outstanding because of the practical and useful nature of the information given.

This book is well organized, has excellent illustrations, and contains a good bibliography. It would be useful as a supplementary book for the physician, nurse and physical therapist.

SYSTEMIC ASSOCIATIONS AND TREATMENT OF SKIN DISEASES. By *Kurt Wiener*, M.D. Cloth. Price, $17.00. Pp. 556, with 90 illustrations. The C. V. Mosby Company, St. Louis, 1955.

The book is divided into two parts: Part One covering Systemic Associations of Skin Diseases; Part Two being devoted to Systemic Treatment of Skin Diseases.

The book is printed on excellent paper, and the binding is of good quality. The illustrations are well selected, sharp and properly placed. The index is good, and the bibliography is extensive, listing 2,759 references.

The author has performed an excellent task in discussing the little known systemic abnormalities associated with skin diseases, which are frequently absent or not stressed in dermatology texts, and in presenting a discussion on modern systemic therapy. The author has listed the various therapies, the useful and the useless. Unless the reader is a dermatologist, he could be confused. It would have been preferable to have discussed in greater detail the valuable forms of therapy and eliminated the useless. In several instances the author did not place proper emphasis on the value of the treatment mentioned.

Clinical judgment and a general knowledge of dermatology are needed by the reader in order to obtain the most out of a textbook of this type. The classification of a few diseases is incomplete which makes their discussion rather general. A good discussion of most diseases is presented especially the collagen diseases to which the first 80 pages have been devoted. Other diseases are not so completely discussed.

This book is a valuable adjunct to a standard textbook on dermatology and is recommended for practicing dermatologists.

PROBLEME UND ERGEBNISSE AUS BIOPHYSIK UND STRAHLENBIOLOGIE. By *W. Friedrich*, and *H. Schreiber*. Cloth. Price, 47,80 DM. Pp. 438, with illustrations. Georg Thieme, Leipzig Cl, Germany, 1956.

This book celebrates the 25th anniversary of the Institute for Radiation Research of the Humboldt University of Berlin. The opening chapter sketches the vicissitudes of the institute, especially during and after World War II.

There are 28 chapters, by different authors, on biophysics in general, on ionizing radiation (with special reference to radioactive isotopes and the cancer problem), on visible radiations, and on ultrasound. Outstanding is a long chapter on current problems in the application of radioactive isotopes; it includes summaries and discussions of the papers given at the second Conference on Radioisotopes in Oxford in 1954, and includes valuable tables and diagrams.

There are indications in the bibliography that some of the authors have been handicapped by not having access to recent publications from other countries. In general, however, the contents are informative, concrete, and accurate, and with its chapter on the scope of biophysics and the training of biophysicists this volume will be of interest to those doing fundamental research in biophysics, radiology, and physical medicine.

RACE AND REICH. The Story of an Epoch. By *Joseph Tenenbaum*. Cloth, Price, $7.50. Pp. 554. Twayne Publishers, Inc., 31 Union Square W., New York 3, 1956.

This book is a history of the Jews in Nazi Germany and in the countries occupied or dominated by the Nazis. It is the story of their persecution from "yellow tag" discrimination to attempted annihilation. The Nazi dogma of race purity permeated all phases of life in the Third Reich — religious, social, economic, military, even scientific. German scientists were conscripted for the war against the non-Aryan, or they enlisted. As the author states so forcefully, "How these founts of knowledge and humanity dried up under the blast of the Nazi sirocco, and how ethical medicine became a criminal science, is the subject of this study." Although this study is thoroughly documented, it is not entirely objective. The author was too intimately involved in the combat against the consequences of Nazi race theories to remain as aloof as a Gunnar Myrdal in "An American Dilemma." This intense feeling for his subject, however, makes the book more interesting reading, as history and as literature. Such phrases as "the scum of the self-appointed master race of fanatical killers" and the ironical tone of the book in general are usually not found in a historical work, but then history has never before witnessed such systematic oppression and destruction of an ethnic group. Anti-

Semitism was required by law. State religion sanctioned the discrimination; members of the cloth who objected were ignored, or silenced. State economy flourished as a result of confiscatory sale of Jewish businesses and plunder of Jewish property. It failed subsequently partly because Hitler's immediate solution to the Jewish problem — concentration camps and slow destruction — and the Final Solution — firing squads, gas chambers, and crematoriums — conflicted with the need in the German war economy for skilled artisans and other laborers represented by the slaughtered Jews. At times the book is as gripping as a tragic novel, its effect cathartic. Interest may lag somewhat in that part of the book giving a country-by-country account of the fate of the Jewish population. Perhaps the author foresaw this since, immediately before a tabular summary of the physical losses suffered by the Jews in these countries, he writes, "One can get indignant, even horrified, about the murder of one, two, ten men, but one cannot have the same reaction where millions are concerned." The book is recommended reading for those too young to have been appalled by the horror associated with the Nazi regime and for those old enough to have forgotten. Of special interest to physicians will be part IX, Case History of a Nazi, a psychological study of Rudolf Hoess, commander of the physical extermination camp at Auschwitz. Also of interest will be the chapter on racial medicine, dealing with euthanasia, mass sterilization, and embracement of nonscientific Nazi racial principles by some German doctors. The book also contains extensive explanatory notes, an exhaustive bibliography, a reproduction of Hitler's last will and testament, and appended sections on gypsy genocide, Hitler's political testament, and a list of the Reich leadership.

HANDBOOK OF PHYSICAL THERAPY. By *Robert Shestack*, P.T.R. Cloth. Price, $4.25. Pp. 212. Springer Publishing Company, Inc., 44 E. 23rd St., New York 10, 1956.

In spite of the title, the publisher of this book claims to present a much greater field including "Resources of Physical Medicine" and an explanation of "the patho-physiological conditions that can be affected by one or the other physical modality." Actually the author has listed brief and often inaccurate descriptions of various methods of physical treatment with a limited amount of specific detail on certain technics. The author, a physical therapist, has attempted to describe many pathologic conditions (which are much better described in other works) and to indicate what the physical therapeutic procedures should be for each condition.

Physicians will not find this book helpful in comparison to present standard references in the field of physical medicine which have been written by medical specialists in the field. The physical therapist is not, by training or experience or professional ethics, qualified to advise physicians on pathology or prescription, and is taught only the technics and procedures of physical therapy. This book adds nothing new to the literature except, perhaps, a brief section on ultrasound which is not sufficiently definitive to be useful.

It is evident that the author has not made use of source materials available in recent scientific and professional periodicals and no such references are listed in the bibliography. Consequently, the sections on electrotherapy do not reflect adequately on current practices. The section dealing with exercise could better have included a discussion of the newer concepts of training in the activities of daily living instead of the brief listing of specific exercises which, as the author states, "Every competent physical therapist can instruct the (patient) to do, without special instruction." Much of the material is out of date, especially the material in the section on hydrotherapy, and much important information has been omitted in some cases, while in other areas extraneous and obvious details have been included.

The result is a superficial, often misleading, and confusing review of a limited portion of the literature on physical therapy with the addition of some of the author's own experiences, which are also of limited importance.

Better editing might have eliminated some of the errors in grammatical construction and improved the general organization. Inaccurate and unscientific use of language distorts the explanation of scientific material.

This book offers nothing for the physician or for the practicing physical therapist that has not already been presented in better form, and one physical therapist has expressed the opinion that it would be, "Worse than useless as a text or source book for the physical therapy student." It is unfortunate that this author ever attempted to go so far beyond his intellectual depths.

MENTAL HYGIENE IN PUBLIC HEALTH. Second Edition. *Paul V. Lemkau*, M.D. Cloth. Price, $8.00. Pp. 486. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, 1955.

The first edition of this book appeared about six years ago. Since that time, remarkable progress and development has been made in the field of mental hygiene. The author incorporated these new ideas in this edition. He successfully discusses the place of mental hygiene in public health and its need for proper leadership, standardization of technic and modes of application. The chapter on methods used is interesting and should benefit the physiatrist who must lead a rehabilitation team in the treatment of patients.

Part two of the book is devoted to the development of the individual. In the first chapter the author touches on some very

controversial matters of eugenics and arrives at certain conclusions which, though appearing scientific, are not logical or morally ethical, especially when he deals with the questions of sterilization and birth control.

The rest of this part describes the patterns of behavior of the infant, starting with intra-uterine life. Such infants may be affected in several ways, psychologically or physically, which may cause maladjustments later in adult life. When he starts walking, the child has reached a dynamic epoch of development, during which time he should adapt himself to the environment. However, these are influenced to a large degree by the attitude of the patients towards their environment and their cultural pattern. In the chapter on the pre-school period, the period of extreme rapid physical, intellectual, emotional and social growth of the child is described.

In succeeding chapters, the author covers the behavior development of the child of school period, adolescent period and the adult from young through to middle age to the old age period.

This is a very interesting book, thoroughly written and showing mature judgment of the author, in spite of the fact that certain theories, suggestions and hypotheses may not be acceptable to some people. This book will prove to be of value to the physiatrist as well as to the auxiliary personnel working in the field of rehabilitation of the disabled.

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For further information regarding these opportunities, please write Burneice Larson, Medical Bureau, Palmolive Building, Chicago.

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